Regulating Housing Quality: Evidence from France*

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Abstract

I provide quasi-experimental evidence that housing quality regulations raise costs and reduce quantities, but also foster endogenous market segmentation. Since 1977, French law mandates the use of an architect for any new home construction or extension, but only above a size threshold. Construction costs and dwelling features jump at the discontinuity, and quality standards distort quantity choices: the size distribution of new homes exhibits bunching below the regulatory notch. Homeowner demographics and location decisions are all discontinuous at the threshold, as the size-dependent regulations act as a focal point, inducing heterogeneous households and producers to sort across fragmented sub-markets, consistent with a structurally estimated model with two-dimensional preferences for quality and quantity.

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 their budget to housing. This "affordability crisis" has led to calls for relaxing regulations perceived as hindrances to new development. However, ensuring that new dwellings, while abundant, remain of high enough caliber, requires walking a fine line between loosening *quantity* restrictions and maintaining *quality* standards. Demonstrating this tension, when releasing his Housing Supply Action Plan, 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]

Academic research (Hsieh and Moretti, 2019; Glaeser and Gyourko, 2018) and policy analyses (Dougherty, 2020) often focus on zoning regulations restricting the *quantity* of new housing construction. By contrast, the literature has mostly ignored regulations regarding housing *quality*, and the trade-offs they face when households respond at both the intensive and extensive margins. The main reason is that quantifying the relevance of such rules is complex. While terms like "neighborhood character", "quality standards" or "aesthetic mandates" abound in building codes, they often do not have a measurable counterpart to credibly estimate the sensitivity of demand and costs to norms and quality constraints.

In this paper, I exploit a unique, sharp *quantitative* variation in *quality* regulations, to estimate their effect on housing production costs and the demand for living space. I show that they act as a focal point, inducing a spatial sorting and market segmentation of households who differ in their preferences for quality. In France, since 1977, filers of permits for any new form of housing are required to hire a licensed architect to prepare, submit, and certify the plans to erect or modify any dwelling. The rule aims at ensuring that only aesthetically pleasing, durable, and safe new housing is built. Individual households, however, can be exempted from the constraint, whenever they build a single-family home whose floor area does not exceed a specific "Architect Requirement Threshold" (*ART*).

This quasi-experiment exposes construction projects varying only slightly in size to distinct quality regulations, creating incentives to reduce the size of units below the *ART*. I

[1]White House briefing (President Biden Announces New Actions to Ease the Burden of Housing Costs), May 2022, emphasis added. Similarly, in the UK, the Prime Minister's Long-Term Plan for Housing in July 2023 committed to "*transformational plans to supply* beautiful, safe, decent *homes in places with high-growth potential*".

leverage this discontinuous variation to shed light on the consequences of quality regulation for costs, quantities consumed, and location decisions. When agents have heterogeneous tastes for quantity and quality, size-dependent regulations can lead to a full segmentation of sub-markets by quality level, beyond local distortions at the notched regulation. In turn, the concentration of demand just below the focal point created by the regulation generates production complementarities and economies of scale in construction, "accidentally" promoting housing density.

I start by developing a model of housing consumption under regulatory frictions, where customers have two-dimensional preferences for quantity and quality. Because households value architect services differently, the requirement to use them above a certain size is not a pure tax notch (a la Kleven and Waseem, 2013), and could affect both quality or quantity decisions. First, as is standard, picking a home size just below the threshold allows *bunchers* to circumvent architect fees, at the cost of deviating from their preferred quantity. Second, *compliers* above the *ART* may upgrade quality beyond their preferred level to satisfy the regulation, rather than suffer large quantity distortions. Third, the two-dimensional approach rationalizes the presence of *always-takers* (households immediately above the notch) by strong enough tastes for quality, rather than the commonly used "adjustment frictions" in the bunching literature (Kleven, 2016).

Leveraging exhaustive administrative data covering all private construction projects in France since 1973, I then exploit the implementation and subsequent reforms of the *ART* to test key predictions of the model and evidence four main reduced-form results.

First, the realized cost of construction jumps upwards at the size threshold, by an amount substantially larger than external estimates of standard architect fees. Regression discontinuity estimates indicate that housing costs for structures are on average 8 to 10 percentage points higher for homes with a size slightly above the architect requirement trigger, relative to those just below. Since the architect mandate can only raise construction costs for consumers who would otherwise not use one ("compliers"), this implies that the minimum quality standard is binding for at least some households. Land costs – but not lot sizes – are also discontinuously higher above the threshold, due to spatial sorting by quality choice.

Second, there is stark bunching in the distribution of dwelling sizes immediately below the regulatory threshold. An excess mass of houses just below the *ART* only appears after the implementation of the threshold at 250 square meters in 1977, and especially following its tightening to 170 m^2 in 1979. This rules out time-invariant explanations based on salient round numbers or technological constraints in construction. The missing mass above the threshold increases over time, suggesting a gradual unraveling of the large homes market segment. Households also respond to variation in rules over time. When the switch to a less comprehensive floor space measurement effectively reduced the stringency of the mandate in 2012, bunching declined in magnitude. Conversely, after the *ART* was lowered to 150 m^2 in March 2017, bunching quickly moved strictly below the new exemption level, with its absolute magnitude rising substantially. Changes in the *ART* level allow me to estimate the counter-factual distribution with a non-parametric fit derived from "placebo" years. Using this difference-in-bunching approach, I find an economically substantial bunching mass of about eight times the counter-factual density at the *ART*, a conclusion similar to the result of standard polynomial-based bunching estimates.

Third, I examine the mechanisms underlying the response to the quality regulation. Households respond both at the extensive and intensive margins. A more stringent threshold is associated with an overall decrease in the number of new construction projects. Extension projects for existing houses, which face complex interlocked regulatory notches, are commonly downsized to prevent triggering the requirement, or to entirely avoid filing for a building license. They are frequently not undertaken altogether for units with an initial floor area close to the limit. The considerable fraction of "always-takers" locating immediately above the *ART* implies that some households value architect services at or above cost, thus remaining unaffected by the rule. I estimate that a non-trivial share of "complier" households further above the threshold abide by the regulation by distorting their quality choice rather than quantity.

Fourth, household characteristics, dwelling features, and spatial location decisions all jump discontinuously at the threshold. Younger and lower-income agents are more likely to bunch in order not to use an architect, due to a higher marginal utility of income and lower value of time, relative to the perceived benefit of architect services. Homes that bunch below the *ART* also locate in municipalities with more construction overall, and a higher share of bunchers among neighbors. Consistent with the presence of scale economies in standardized housing production, the regulation unintentionally boosts the production of similarly-sized houses in a specific range just below the ART, generating significant economies of scale in both design and production. On the other hand, in line with the model's predictions, "always-taker" and "complier" houses just above the size threshold – with a higher revealed preference for architect services – face more idiosyncratic complexity, are less likely to be part of homogeneous joint development projects, take longer to finalize, and are more often used as second homes and built for long-distance owners. They also locate in more expensive municipalities with higher average incomes and more inequality.

Finally, I structurally estimate the model, parameterized to match the observed distribution of quantity choices. I evidence a welfare loss concentrated among households with counter-factual choices above but close to the threshold, and an aggregate but heterogeneous decrease in the consumption of living space owing to the regulation. Overall, the requirement leads to a misallocation of housing consumption across families and locations; to a potentially regressive transfer of rents away from less sophisticated households, and towards higher-income licensed professionals; and to a broad-based segmentation of housing markets by quality. For the regulation to be welfare-improving would require architect-built houses to exert substantial positive externalities, in the order of 3 to 4 cents per dollar spent on architect services.

Contribution to the literature This paper relates to two distinct strands of research. First, it adds to a growing body of work on the consequences of housing regulation — reviewed in depth by Gyourko and Molloy (2015). Rules like minimum lot sizes or maximum floor-area ratios constrain the provision of housing. Their varying stringency across places and over time is widely thought to affect how easily new construction responds to increasing demand (Ihlanfeldt, 2007; Glaeser and Gyourko, 2018).

Obtaining credible causal evidence on their impact, however, is difficult. First, data on regulation stringency are scarce, despite efforts to harmonize local regulatory information (Hilber and Vermeulen, 2016; Gyourko, Hartley, and Krimmel, 2021). Second, building rules are not randomly assigned. They are the byproduct of political economy processes, which coincide over time and across locations with housing demand and supply, blurring their estimated causal impact (Davidoff et al., 2016). My paper makes progress on identification by exploiting administrative permits data and a sharp, dwelling-level discontinuity in regulations between houses that are comparable, but for the fact that their floor space places them on either side of a legal threshold.[2] This allows me to provide, to the best of my knowledge, the first direct evidence on the *intensive margin* response to regulation for homeowners, and to document the spatial sorting consequences of quality requirements.

On the other hand, this paper is connected to a broader research agenda exploring the welfare consequences of size-dependent regulations 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). Two studies – on the conforming loan limit by DeFusco and Paciorek (2017), and on the mortgage interest tax deduction by Hanson (2020) – adopt a bunching approach to quantify borrower choices driven by discontinuous variation in interest rates in the US mortgage market. While my design also relies on bunching, I study the effect of regulations on the physical size of new units, rather than the amount of borrowing. Unique data on housing permits directly demonstrate a real quantity response for housing space, and allow me to explore the underlying mechanisms of sorting.
Methodologically, my model with two choice variables (one continuous and one discrete) speaks to recent advances in the bunching literature (e.g. Cox, Liu, and Morrison (2021)). Using changes in the threshold to identify "bunchers", "always-takers", and "compliers" relates to the estimation of welfare effects of changing notches in transfer programs (Bergstrom, Dodds, and Rios, 2022). Several papers adopted bunching designs to study size-dependent, or "attribute-based", regulations, for energy efficiency (Ito and Sallee, 2018),[3] government procurement (Carril, 2019), or financial disclosure (Ewens, Xiao, and Xu, 2021). My empirical analysis provides novel evidence that such discontinuous size-dependent rules can foster a complete segmentation of consumers in the market, and the threshold acts as a focal point that divides sub-markets by quality level.

[2]Recent work on the 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), relies on *spatial* discontinuities at the boundary between jurisdictions. By contrast, the size-based quality regulation I study operates across units along the intensive margin choice of housing quantity.

[3]Ito and Sallee (2018) define "an attribute-based regulation" as one that "aims to change one characteristic or behavior [...] (the "targeted characteristic"), but [...] takes some other characteristic or behavior (the "secondary attribute") into consideration when determining compliance". They formalize conditions under which distributional and efficiency motives can rationalize attribute-basing.

2 Institutional background and data

2.1 Institutional setup

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 extension of existing ones, must comply with a wide array of constraints, including a maximum built area per acre of land, minimum parking requirements, or energy efficiency mandates.

Among the most salient regulations is a 1977 law[4] requiring households filing for a permit to have plans certified by a licensed architect[5] for the construction or modification of any building. The official motive for the mandate was to ensure minimal quality and safety standards in the housing stock, and maintain "neighbourhood character". Individuals however are not required to use an architect for a unit with a floor space below $\bar{h}$: the architect requirement threshold (*ART*). Households who do not use an architect to establish, submit, and certify plans often either design their homes by themselves; or resort to the services of large corporate builders (*constructeurs de maisons individuelles* or *CMI*) who specialized in standardized home construction.

The exemption level $\bar{h}$ was first set at 250 square meters (c. 2,690 square feet) in January 1977. Starting October 15$^{\text{th}}$, 1979, it was reduced to 170 square meters (c. 1,830 square feet), a threshold that remained in force until March 2017. The floor space definition used for the *ART* (as well as for all other zoning rules) changed several times since 1977. From January 2007 to March 2012, the relevant area was the *SHON*, an acronym standing for *Surface Hors Oeuvre Nette*, or "Net Area of 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. The *SHON* allows for a 5 percent flat deduction to the floor space thus calculated. The post-2007 period thus constitutes the core sample for my analysis of bunching below the ART.

[4] Article 3 of the January 3$^{\text{rd}}$, 1977 law n. 77-2 on Architecture.

[5] 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.

The 2012 change in floor space definition In 2012, as part of its climate strategy, France implemented new energy-saving regulations in the residential construction sector, the ”2012 thermic regulation” (*RT 2012*). To encourage better housing insulation, the *RT 2012* adjusted the computation of floor space used in all urban planning regulations to only count indoors floor space. Houses using thicker, better insulated external walls to lower energy consumption would no longer need to reduce indoor areas to meet planning requirements. Therefore, the ”floor area” (or *SDP* for *Surface de Plancher*, replaced the *SHON* after March 1, 2012. The *SDP* is computed starting from the *inside* of external walls, unlike the *SHON*, which started from the *outside* of the structure. Online appendix figure A.1 compares the two measures: due to the exclusion of external walls, the *SDP* was generally c. 10 percent smaller than the *SHON* – depending on the shape of the dwelling and thickness of the walls. The switch to the *SDP* loosened the architect mandate[6] by raising the quantity of indoor space below which the exemption applied.

The 2017 change in the level of the *ART* In 2017, the level of the threshold was lowered to 150 m^2 of *SDP*. The stated objective was to roughly match the pre-2012 stringency, since an *SDP* of 150 square meters corresponded on average to a *SHON* of 165 to 170 m^2.[7] The 2017 change fostered incentives to distort housing consumption at previously unaffected levels of *SDP*, relative to the situation prevailing from 2012 to 2017. I exploit the 2017 adjustment in a difference-in-bunching empirical strategy to assess the intensive and extensive margin responses to quality regulations, and estimate the share of compliers.

The special case of additions If the size-dependent rule only applied to initial constructions, a simple avoidance strategy to reach a preferred size would involve gradual additions to a project initially below the *ART*. To circumvent project-splitting incentives, additions are also subject to the architect mandate. If the owner of a house of *existing* size h^E expands it by h^N and files a building license, they must use an architect if the completed size is above the *ART*: $h^N + h^E \geq \bar{h}$. This creates incentives to downsize additions, so that the *completed* unit

[6]An additional ”dual test” was introduced to take into account the overall footprint of a construction. Appendix A provides additional institutional details on the March 2012 reform and the various adjustments to the computation made from March to May 2012.

[7]The dual test was eliminated: only the *SDP* would count towards the exemption level.

remains strictly below the *ART*, by choosing h^N immediately below $\bar{h} - h^E$.

However, there is no need to file a building license – and thus no architect requirement – when the size h^N of the addition itself is below a "BL threshold", h_{BL}.[8] Before 2012, the BL threshold h_{BL} was 20 sq.m everywhere. It was raised to $h_{BL} = 40$ in urban areas after January 2012, while remaining at 20 in rural areas. This creates additional incentives to bunch the size of an extension project, h^N, strictly below $\bar{h}$ (20 or 40).[9] Appendix figure C.1 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. At all existing sizes h^E, there is a strong rationale to build extensions smaller than h_{BL}, in order not to file for a BL altogether. For small enough additions ($h^N < h_{BL}$), there are no incentives to bunch the completed size ($h^C = h^E + h^N$) below $\bar{h}$, and the project requires neither a building license nor an architect. I examine discontinuities in these incentives 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 costs, consumption, and segmentation, I use the *Sit@del2* database, an administrative repository containing detailed information on the universe of housing permits requested in France since 1973. 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 residential units. On average, over the 2010-2019 decade, the *Sit@del2* database counts around 130,000 authorized new single-family housing units every year, and 165,000 approved extension projects for existing dwellings.[10]

[8]The architect mandate can only apply to projects for which a *building license* (BL) is required, and only construction projects with a floor space larger than h_{BL} square meters must obtain a BL. Construction projects below 5 square meters require no formal registration. Construction projects larger than 5 square meters, but below h_{BL}, are allowed to use a tacit approval expedited processing method, the *Declaration prealable* or "Pre-registered Statement" (PS), instead of a BL.

[9]In the $20 \leq h^N < 40$ interval, an architect was still mandatory in urban areas, if (i) the initial floor space h^E was less than the *ART* $\bar{h}$ and (ii) the addition would push the complete footage $h^E + h^N$ above $\bar{h}$.

[10]Other building licenses in the sample correspond to small modifications of the exterior aspect of houses, or to commercial, multi-family, industrial, or agricultural building projects. Only individuals who build a home for their own dwelling purposes 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 floor space. Agricultural constructions benefit from a higher exemption

I focus on the 2007-2011 period to analyze the 170 square meters of *SHON* threshold; on 2013-2016 for the *SDP*-based 170 square meters threshold; and on the post-2018 period for the consequences of the reduction of the *ART* to 150 m^2 of *SDP* in 2017. In robustness checks, I also exploit 1973 to 1985 data to study the implementation of the threshold at 250 square meters in 1977 and its lowering to 170 in 1979. The *Sit@del2* database provides information on the timing and processing of construction projects, as well as some additional details on their exact geo-location, which allows me to match each project to ZIP code-level demographics from a variety of sources, including Census, Treasury, and housing transactions (*DV3F*) data. However, a key limitation in the data is the absence of cost information, or detailed household demographics. I therefore complement the data with project level microdata from two annual surveys. First, I use the EPTB survey[11], 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,[12] in which a random sample of individual building licenses drawn from the *Sit@del2* database are surveyed every year to obtain more detailed information on the cost and nature of the projects they correspond to, as well as additional household demographics.

3 Conceptual framework and research design

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

I develop a pared-down model of housing consumption involving a continuous *quantity* decision (how much livable space to purchase), and a discrete *quality* choice (whether or not to use an architect), under regulatory frictions. I test its qualitative implications for dwelling sizes and household sorting in section 4, before structurally estimating a parameterized version to quantify welfare consequences and counter-factual rule changes in section 5.

threshold. Both are excluded from the main analysis sample.

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

[12] *Enquete sur le Prix de Revient des Logements Neufs*: Survey on the Cost of Newly Built Dwellings. In particular, this survey is used to build nationwide indices of construction costs for rent controls.

Behavior under laissez-faire Agents consume a quantity h of housing, at user cost p_H, and a composite basket of other goods c (the numeraire). They also make a binary quality choice: using the services of an architect ($A = 1$) or not ($A = 0$), at the cost of a fixed fee F.[13] Households have income y, and maximize utility (parameterized by a vector of tastes for quantity and quality Θ):

$$max_{h\in\mathbb{R},A\in\{0,1\}}u(c,h,A,\Theta) \text{ subject to } c + p_H \times h + F \times A \leq y \tag{1}$$

Under laissez-faire – denoted with superscript x^L – an agent with tastes Θ computes optimal quantity choices conditional on architect use, then picks the maximum indirect utility with ($v^{L,A^L=1}(y, p_H, F, \Theta)$) or without an architect ($v^{L,A^L=0}(y, p_H, \Theta)$):

$$A^L = \text{argmax}_A \left[v^{L,A^L=1}(y, p_H, F, \Theta), v^{L,A^L=0}(y, p_H, \Theta)\right]$$

$$h^L = A^L \times \text{argmax}_h u(c,h,1,\Theta) + (1 - A^L) \times \text{argmax}_h u(c,h,0,\Theta)$$

Given un-distorted choices $\left(h^L, A^L\right)$, a well-behaved distribution of tastes Θ gives rise to a (counter-factual) smooth density of *quantity* choices summing vertically the marginal densities for architect users and non-users:

$$g^L(h) = g^{L,0}(h) + g^{L,1}(h)$$

Household choice with quality regulation I next introduce a rule (with choices indicated by superscript x^R) requiring households consuming more than $\bar{h}$ to use an architect. The new – constrained – household problem is (1), subject to an attribute-based quality standard:

$$A^R \geq \mathbb{1}[h > \bar{h}] \tag{2}$$

The table below summarizes the incentives faced by households of various types, given their counterfactual choices. Households with a high taste for quality ("always-takers") use

[13]This premium is modelled as a fixed additional fee, leading to an increase in average costs starting from the first euro of housing consumption, to relate closely to the empirical findings of my study. Modelling the fee as proportional to total costs yields similar qualitative and quantitative implications.

an architect under laissez-faire ($A^L = A^R = 1$), even absent the regulatory constraint (2). They are unaffected by the rule, whether or not they consume more than $\bar{h}$. Under laissez-faire, "never-takers" households consume a quantity below the threshold ($h^{L,0} \leq \bar{h}$) and do not resort to an architect ($A^L = 0$). Their choices are also undistorted by (2): the counter-factual decision remains *a fortiori* optimal under the regulation ($h^{R,0} = h^{L,0} \leq \bar{h}$, $A^R = A^L = 0$).

		Quality choice absent regulation	
		Architect	No architect
Quantity choice absent regulation	Above $\bar{h}$	No effect (*always-takers*)	Distort quantity (*bunchers*) / Distort quality (*compliers*)
	Below $\bar{h}$	No effect (*always-takers*)	No effect (*never-takers*)

Summary of incentives relative to counter-factual choices absent regulation

The only directly affected households have counter-factual choices $A^L = 0, h^{L,0} > \bar{h}$ in the upper-right quadrant of the table.[14] When re-optimizing subject to (2), agents with a sufficiently high valuation for quality ("compliers" with $\Theta \in C(h^I)$) consume an interior amount $h^I > \bar{h}$ above the threshold but now use the services of an architect $A^R = 1 > A^L$, upgrading and distorting *quality* to comply. Alternatively, affected agents with a lower valuation of quality ("bunchers" with $\Theta \in B$) reduce housing *quantity* by bunching consumption immediately below the regulatory notch ($h^{R,0} = \bar{h} < h^{L,0}$), to remain exempt from the mandate ($A^R = 0 = A^L$) while locating as close as possible to their preferred quantity choice.

The *observed* density of housing *quantity* choices with the regulation, $g^R(h)$, is still the vertical sum of densities for users and non-users of architects:

$$g^R(h) = g^{R,0}(h) + g^{R,1}(h)$$

Choices strictly below the notch ($h < \bar{h}$) are the sum of never-takers and always-takers. Both

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

are undistorted and equal to their counter-factual distributions:

$$g^{R,0}(h) = g^{L,0}(h) \text{ and } g^{R,1}(h) = g^{L,1}(h) \text{ for } h < \bar{h}$$

Exactly at the notch ($h = \bar{h}$), the density of architect users equals the counter-factual density of users (always-takers). On the other hand, the density of non-users at $\bar{h}$ is the sum of counter-factual never-takers $g^{L,0}(\bar{h})$, and the total number of bunchers (with parameter vector $\Theta \in B$):

$$g^{R,1}(\bar{h}) = g^{L,1}(\bar{h}) \text{ and } g^{R,0}(\bar{h}) = g^{L,0}(\bar{h}) + \int_{\Theta \in B} \int_{\bar{h}}^{+\infty} g_{\Theta}^{L,0}(k) dk d\Theta$$

For interior choices above the notch ($h^I > \bar{h}$), the density of non-architect users is $g^{R,0}(h^I) = 0$ by virtue of (2). In addition to always-takers, users now also include compliers who did not bunch and locate at h^I (those with $\Theta \in C(h^I)$):

$$g^{R}(h^I) = g^{R,1}(h^I) = g^{L,1}(h^I) + \int_{\Theta \in C(h^I)} \int_{\bar{h}}^{+\infty} g_{\Theta}^{L,0}(k) dk d\Theta \text{ for } h > \bar{h}$$

The price of housing increases discontinuously at the notch: households above the threshold pay a price $p_h \times h + F$; but the unit price immediately below the notch is a weighted average of costs for always-takers and non-users (bunchers and never-takers): $\lim_{h \to \bar{h}^-} p_h(h) = \frac{(p_h + \frac{F}{\bar{h}}) \times g^{L,1}(\bar{h}) + p_h \times (g^{L,0}(\bar{h}) + B)}{g^R(\bar{h})}$ (B is the bunching mass).

3.2 Bunching estimation

Figure 1 describes the stylized laissez-faire and actual distributions of dwelling sizes. Under an attribute-based regulation, the behavior of the overall density (relative to its estimated counter-factual) can be used to reveal both the reaction of *bunchers* (at the quantity threshold), and of non-bunchers – who are either unaffected *always-takers* and *never-takers*, or distorted *compliers* with the rule who upgrade the quality decision.

Heuristically, the excess density *at the threshold* $\bar{h}^-$ measures the number of bunchers ($\Theta \in B$). Immediately *above* the threshold, at $\bar{h}^+$, bunching involves reducing quantity by a near-zero amount and would be close to costless, so that there are approximately no compliers: $C(\bar{h}^+) \simeq \emptyset$. Thus the observed density at $\bar{h}^+$ provides an estimate of the local share of always-takers. Finally, changes in the density further to the right of the notch (where $C(h^I) \neq \emptyset$) are informative about the local share of compliers. To estimate the size of these responses at the regulatory notch requires comparing counts $N(h)$ of new homes with a floor space of h square meters to an estimate of the distribution $\hat{N}(h)$ that would be realized absent the size-based regulations.[15] I use two different estimates of this counter-factual distribution.

Polynomial approach The first methodology relies on a standard polynomial approximation of the density outside the manipulation range (Chetty et al., 2011). I restrict the data to all new housing projects with a floor space above 40 square meters, and below 400 square meters, from 2013 to 2016.[16] I regress counts of projects in each 1 square meter bin of *SDP* on a K-order polynomial of the floor area, and fit the observed distribution, excluding the manipulation range (corresponding to units with a floor space between h_L and h_U), and including an indicator for bunching at round and salient numbers in the (potentially empty) set S_t outside the manipulation range[17]:

$$N(h) = \sum_{k=0}^{k=K} \beta_k h^k + \sum_{i=h_L}^{h_U} \delta_i \mathbb{1}(h = i) + \sum_t \theta_t \mathbb{I}\{\frac{h}{t} \in \mathbf{N}\} + \epsilon_h \tag{3}$$

The predicted density, excluding the contribution of dummies for the bins in the manipulation range, provides a hypothetical counterfactual $\hat{N}^{\text{Poly}}(h) = \sum_{k=0}^{K} \hat{\beta}_k h^k + \sum_t \theta_t \mathbb{I}\{\frac{h}{t} \in \mathbf{N}\}$. Bunching is then defined as the excess mass below the regulatory notch

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

[15]The data report floor space for each construction projects only in integer square meters.

[16]This corresponds to close to 500,000 distinct approved housing projects. The time frame restriction ensures a consistent computation of the floor space – the *SDP* – was used throughout. The exclusion of projects below 40 square meters selects homes with a building license throughout the 2013-2016 period, since new units with a floor area below 40 square meters were not required to file for a BL in urban areas.

[17]The set of round and/or salient numbers $S_t = \frac{h}{t} \in \mathbf{N}$ is empty in the baseline empirical application, and includes multiples of 10 square meters in robustness checks. The degree $K = 9$ of the polynomial is chosen to optimize the Akaike Information Criterion, and I vary K and the upper bound h_U in robustness exercises.

As is customary in the bunching literature, and given the graphical starkness of bunching, I obtain h_L as the first point where the slope of the density switches from negative to positive under the notch, and vary the upper bound of the bunching interval h_U in robustness exercises. Standard errors are obtained using the bootstrap procedure of Chetty et al. (2011).

Difference-in-bunching approach In the second approach, I rely on changes in the notch over time, after the 2017 reform lowered the threshold from 170 to 150. Before 2017, when the notch was located at the higher 170 sq.m ART, the density at 150 sq.m was un-distorted (and composed of a mix of always-takers and never-takers). The smoothness of quantity choices around the 150 notch in "placebo" years enables the construction of a counterfactual distribution, $\hat{N}^{\text{Placebo}}(h)$. Specifically, in order to measure bunching in the post-reform period at the new 150 sq.m of *SDP* notch, I use the pre-reform 2013-2016 distribution around 150 square meters as an undistorted counterfactual. To allow for time trends in overall new construction, I re-scale the counter-factual counts so that the total number of units below 140 square meters is similar in the pre- and post-reform periods. Formally, I rescale counterfactual relative frequencies from 2013-2016 to match the 2018-2019 total counts:

$$\hat{N}^{\text{Placebo}}(h) = \frac{N^{\text{Pre}}(h)}{\sum_{h' \leq 140} N^{\text{Pre}}(h')} \times \sum_{h' \leq 140} N^{\text{Post}}(h') \tag{4}$$

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

Marginal bunching response Estimates of the bunching mass $B(\bar{h})$ obtained from either the polynomial (equation 3) or placebo notch approach (equation 4) allow me to quantify the magnitude of the response to the regulation. The extent of bunching at $\bar{h}$ satisfies an integration constraint (for non-users) up to the average marginal buncher (among non-compliers):

$$B(\bar{h}) = \int_{\Theta \in B} \int_{\bar{h}}^{\bar{h} + \Delta h(\Theta)} g_{\theta}^{L,0}(h) dh d\Theta \simeq \int_{\Theta \in B} \Delta h(\Theta) d\Theta \times g^{L,0}(\bar{h}) \tag{5}$$

where the approximation assumes the (conditional) counterfactual density of non-users is constant in the interval immediately above the notch.[18]

To quantify $g^{L,0}(\bar{h})$ at the notch (the counterfactual number of non-users) requires scaling down the counter-factual estimate of the overall density $g^{L}(\bar{h}) = g^{L,1}(\bar{h}) + g^{L,0}(\bar{h})$. Similar to the "bunching hole" approach of Kleven and Waseem (2013), this requires "grossing up" the estimate of the marginal buncher, Δh, by $\frac{1}{1-a(\bar{h})}$ where $a(\bar{h}) \simeq a(\bar{h}^{+}) = \frac{g^{L,1}(\bar{h}^{+})}{g^{L,1}(\bar{h}^{+})+g^{L,0}(\bar{h}^{+})}$ is the fraction of "always-takers" households – with a high enough taste for quality to use an architect at $\bar{h}$ even absent the regulation. I therefore estimate $a(\bar{h}^{+})$ as the ratio of the observed density immediately above the notch to the counter-factual estimated density.

Additions to existing houses I also examine the behavioral response of owners of single-family units who expand existing homes.[19] As explained in section 2.1, they can pick an extension of size h^{N} so that total size $h^{E} + h^{N}$ is strictly below $\bar{h}$; or an extension smaller than h_{BL}, the threshold below which no BL is required. First, I quantify strategies designed to reduce the total area of the unit below $\bar{h}$. I compute the floor space of the completed project as the sum of the area of the existing unit, plus any additions, minus any demolitions. Similar to equation 3 for new homes, I examine bunching 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:

$$E(h) = \sum_{k=0}^{k=K} \beta_k^E h^k + \sum_{i=h_L}^{h_U} \delta_i \mathbb{1}(h = i) + \sum_t \theta_t \mathbb{I}\{\frac{h}{t} \in \mathbf{N}\} + \epsilon_h \tag{6}$$

As before, the predicted distribution from the polynomial regression (including the contribution of an indicator for bunching at round, salient numbers) constitutes the hypothetical counterfactual $\hat{E}^{\text{Poly}}(h) = \sum_{k=0}^{K} \hat{\beta}_k^E h^k + \theta_t \mathbb{I}\{\frac{h}{t} \in \mathbf{N}\}$. Bunching then corresponds to the excess

[18] 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.

[19] Additions only start to be reported exhaustively and consistently in the data after 2008, so I focus on the 2009-2019 time period. The data from 2009 to 2019 contain slightly less than 1.3 million approved extension projects of existing homes with exhaustive data on the floor space of the completed unit and the extension.

mass of extensions below the notch:

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

Second, I use a regression discontinuity approach to demonstrate that owners choose to build extensions below the BL threshold, h_{BL}, 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 change discontinuously due to the ART whenever the existing size of the unit is located between $\bar{h} - h_{BL}$ and $\bar{h}$. Therefore, I estimate $r_{h_{BL}}(h^E) = \frac{f_{h_{BL}}(h^E)}{f_{h_{BL}+1}(h^E)}$, the fraction of extensions with a size immediately below h_{BL} relative to extensions with an area of $h_{BL} + 1$, along the distribution of initial sizes h^E.

4 Empirical effects of quality regulations

4.1 Cost effects of quality regulations

I first show that the construction cost for new units jumps exactly at the architect requirement threshold. Using data on the subset of new home building permits that were surveyed to obtain detailed information on project costs, I offer direct evidence that homes with a floor space immediately above the threshold indeed present discontinuously higher construction costs than those immediately below. Figure 2, panel (a), displays the average structure cost in each 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 floor space. While costs increase linearly with size on both sides of the policy notch, a visible jump in raw prices occurs exactly at the prevailing *ART*, consistent with the regulation raising costs for homes subject to the mandate. Appendix figure C.2 shows that houses on the right-hand side of the threshold appear to cost about 9 log points more than those on the left-hand side of the threshold, a discontinuity representing about 10% of the baseline cost, or 125 EUR out of an average cost per square meter of 1250 EUR on the left-hand side of the threshold. The discontinuity is present at the ART – and only there – both in the 2012-2016 period (panels (a) and (c), with a 170 m^2 *ART*) and in the post-2018 period (panels (b) and (d), when the threshold was at 150 m^2), implying that it is indeed driven by the architect mandate rather than other discontinuous costs arising at 170 square meters.

Unlike the case of a notched tax, such a jump is not mechanical; indeed, using an architect is always an available choice for any home size. Its presence implies the regulation binds for at least some households at the threshold, as per the framework of section 3. The discontinuous increase in overall construction costs implies high marginal costs for additional space immediately in excess of the threshold. A "flat fee" interpretation is also consistent with the fact that average construction costs per square meter are flat on the left-hand side of the threshold, but exhibit a declining pattern with size on the right-hand side of the 170 sq.m. threshold.

At the *ART*, an upwards jump is also visible for the cost of land. Panel (b) of figure 2 documents that the cost of land also jumps discontinuously for houses built with a floor space above the threshold. Appendix figure C.3 documents this discontinuity in land prices both in the 2012-2016 period above 170 square meters of *SDP*, and in the post-2018 period above 150. Land prices on the right-hand side of the threshold are about 15 to 20% higher, an increase of about 20 EUR/square meter of land over the baseline cost of 100 EUR. Houses on the right-hand side of the threshold also display significantly more dispersion in land costs per square meter. If the cost of the regulation for larger homes was partly capitalized in the willingness to pay for land, we would expect a *drop* in land prices at the threshold. In contrast, the visible *increase* implies that the regulation is likely to not only lead to higher construction costs (as reflected in the cost of structures), but also to a segmentation of the housing market by quality level and willingness-to-pay, across locations with varying underlying land prices, a spatial sorting effect explored further in subsection 4.5.

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. above the *ART*. Appendix figure C.4 documents (for both the 2013-2016 and the post-2018 periods) that delays are systematically longer on the right of the threshold, consistent with the idea 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 causal 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 Bunching response to quality regulation

I then show that the binding *quality* regulation entails substantial *quantity* distortions for the size of newly built units, in response the discontinuous jump in costs associated with locating above the *ART*. In particular, I evidence that households respond to higher costs by adjusting the floor space of both new units and additions below the *ART*, in order to circumvent the architect mandate, leading to economically meaningful reductions in the real quantity of living space they consume.

Descriptive evidence Figure 3 provides descriptive evidence of bunching for selected years in the main analysis sample.[20] The year-by-year panel of histograms demonstrates that the distribution of home sizes was smooth in 1976 (panel (a)), before the implementation of the architect mandate. Bunching appears at the 250 square meters mark after the regulatory notch was first implemented: the first full year of bunching at 250 square meters occurs for building licenses requests filed in 1978 (panel (b)). The excess mass and bunching behavior moves 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), as shown by panel (c).
Bunching displays a peculiar pattern over time: while the excess bunching mass remains at a similar magnitude between 1980 and 2000 (with a peak around 1.25% of all units), the missing mass immediately above the threshold increases substantially over the period. Immediately above the notch, the share of homes drops from about 0.5% in 1980 to less than 0.25% in 2000 (panel (d)). This suggests a potential long-term unraveling of the market for larger homes subjected to the mandate as of right. 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 bunching below the threshold, the re-

[20]The corresponding floor space is expressed in units of the measure applicable at the time; therefore, it corresponds, in the language of section 2.1, to the *SHON* from 2007 to March 2012, and to the *SDP* after March 2012.

maining households above the notch are known to be less elastic and architects offer higher-markup services, further enhancing incentives to sort below the threshold. Such a dynamic process, reminiscent of Atal et al. (2022), leads to a gradually increasing missing mass above the threshold.

As mentioned in section 2, the exemption from the architect mandate below the *ART* only applies to natural persons, not to corporations or other juridical persons. Appendix figure C.5 compares 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. The "juridical persons" distribution (a substantially smaller total number of new constructions) does not exhibit any evidence of bunching in relative frequencies at the $\bar{h}$ threshold, confirming the hypothesis that the excess mass visible among units built by natural persons is indeed driven by the exemption, rather than by alternative institutional constraints, round numbers, salience of the 170 square meters level, or other technological reasons.

Polynomial approach I next implement the polynomial approach to estimating the counter-factual distribution described by equation 3. Figure 4 displays counts of homes in bins of 1 square meter in 2013-2016, as well as a polynomial fit of order 9 shown to fit the distribution of housing consumption fairly closely across non-manipulation region choices.[21] The visual depiction of the distribution evidences two main results. First, it exhibits a clearly visible and substantial spike in the immediate lower vicinity of the threshold (among projects with a size from 166 to 169 square meters). Most of the bunching response is concentrated in the 168 and 169 square meters bins. Second, there is a sharp drop or "missing mass" immediately above the threshold, relative to the smoothed polynomial estimate of the counter-factual distribution plotted on the same figure, with convergence between the two series reaching up to 200 square meters.

The bunching mass of about 12,000 units (over four years) hovers around 10% of the counter-factual density at the threshold. As summarized in table 1, the exact quantification of bunch-

[21]The presence of bunching is also visible in alternative years and sub-samples, when a different definition of the floor space was in force. As an example, pooling together all c. 760,000 building licenses for new housing units approved from 2007 to 2011, appendix figure C.6 displays similar results for a polynomial fit during the 2007-2011 period, under the alternative *SHON* definition of the floor space. The 168 and 169 square meters bins 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).

ing is sensitive to the use of alternative polynomial approximations of the counter-factual density. The estimated bunching mass ranges from 5 to 13 percent of all newly built homes (depending on the order of the polynomial and upper limit of the excluded range), motivating a more stable estimation strategy based on the difference in bunching in years with varying levels of the notch.

Placebo notch approach after 2017 As an alternative estimation 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 more robust to mis-specification of polynomial fits for the counter-factual density. In particular, I exploit the ”placebo notch” approach described in section 3. Appendix figure C.7 plots raw counts of units by size to demonstrate how bunching immediately moved towards the 150 m^2 new regulatory notch after March 2017. Bunching at the 170 m^2 mark, which was prevalent in 2013-2016, entirely disappears after the change 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.

As formalized by equation 4, 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 m^2 ART in the 2013-2016 period, pre-reform re-scaled counts provide a relevant counterfactual to compute the excess mass immediately below 150 sq.m. of *SDP*. Figure 5 graphically describes the empirical implementation of this alternative identification strategy.[22] Well below the bunching region, over the 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 close to eight

[22] 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. The missing mass above the regulatory threshold, however, cannot directly be estimated using this method, since the placebo distribution around 170 square meters is affected by the pre-reform notch at the former *ART*.

times the counter-factual density to the left of the threshold ($\hat{b} = 7.67$, $s.e. = 0.14$). [23]

Always-takers and compliers The placebo notch approach described in figure 5, exploiting the switch from an *ART* of 170 to 150, allows for two additional considerations. First, a substantial number of households locate immediately above the *new* notch of 150 (about 0.5% of all new construction locates in bins $h = 150$ and $h = 151$). Since a very small reduction in housing consumption would allow these households to avoid spending a discrete amount on architect fees if they wanted to, these households are "always-takers" who strictly prefer using an architect even absent the regulation ($A^L = 1 = A^R$, see figure 1). Such always-takers correspond to $\hat{a} \simeq 40\%$ of the estimated counter-factual density at $\bar{h}$.[24]
Second, the behavior of the density at the *pre-reform* notch of 170 can be exploited to estimate compliance with the regulation. In the pre-reform 2013-2016 period, households locating immediately above 170 were "always-takers", for the same reason as above. By revealed preference, these households strictly prefer using an architect, since they could avoid doing so at the cost of only a tiny deviation in their quantity choice. In the 2018-2019 period, however, the density at 170 is composed of a mixture of two types: those always-takers, but also additional "compliers" who distort quality choices ($A^R = 1 > A^L = 0$). Using the counter-factual distribution at the old notch as a measure of the always-takers share, I compute compliers as the remainder of the actual density. Locally, I estimate the share of compliers at bin $h = 171$ (20 square meters away from the new threshold) to be about 30% of the actual mass of households, suggesting substantial distortions of the *quality* decision far above the threshold.

4.3 Mechanisms underlying the response

I now provide additional evidence on the dynamics of the bunching response to 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.

[23] Reassuringly, in unreported results, the placebo notch approach to estimating the excess bunching mass in the post-2018 distribution provides quantitatively similar results to adopting the polynomial fit approach in the same post-reform period around the new ART of 150 square meters.

[24] Due to round number bunching, the estimate of $\hat{a}$ is higher when using 150 as the "immediate" post-notch bin ($\hat{a} = 0.63$, $s.e. = 0.02$) than when using 151 ($\hat{a} = 0.33$, $s.e. = 0.02$). 40% is an average share over the three bins above the notch.

Household information: the 2012 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, starting from the inside of external walls meant its effective stringency was reduced by the less inclusive *definition* of the floor space. Appendix figure A.5 documents bunching at the 170 square meters regulatory threshold during this interim period (2013-2016), relative to the distribution in the 2007-2011 period under the earlier computation. Since floor space is reported in square meters of *SDP* during 2013-2016 (but 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 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 preferred floor 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 counter-factual density of consumption choices absent any regulation is lower. It also shows that households rapidly understand and react to technical changes not only in the level of the threshold, but in the computation of the measurement used in the regulation.

Dynamics in response to the 2017 reform Next, I turn to the dynamics of floor space consumption after the March 2017 reform adjusted the *ART* downwards substantially, from 170 to 150. I plot in appendix figure C.9 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 $(140 - 150)$ (new bunchers) and in the $[171 - 180]$ sq.m. range (additional compliers) increase substantially.

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 appendix figure C.9) 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 C.10. This methodology demonstrates that about half the new bunching response comes from "counter-factual bunchers" at the 170 threshold, while the other half comes from "counter-factual non-bunchers" in the new missing mass region (151-164).

4.4 Quality regulation and the expansion of existing housing

A common concern in the presence of non-linear incentives, such as size-dependent regulations, is the potential for "splitting", i.e. the arbitrage opportunity stemming from transforming a project above the threshold into several sub-projects that all fall below the level at which the 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 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. On the other hand, the choice of additions to the existing housing stock is also likely distorted by the presence of the architect mandate.

4.4.1 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, expansions 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 $\bar{h}$ triggers the mandatory use of the services of an architect. In Figure 6, I plot the total (post-addition) floor space of completed units that underwent a modification 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* floor space ($h^E + h^N$) 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 additions, the threshold is "unit-specific": each household must compute the optimal maximum size of the addition $\hat{h^N}(h^E) = \bar{h} - h^E$ in order to remain below the threshold. Second, there is clear evidence of a large missing mass of completed sizes to the right of the threshold. This suggests that for extensions of existing dwellings, extensive margin responses may be substantial, with a large proportion of additions not taking place altogether, because they would bring the total floor space 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 precisely where the overall floor area of the unit is exactly below the threshold of 150 square meters in 2018 and 2019, as shown in appendix figure C.11.

4.4.2 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 another way. They can build a small enough extension that a building license (BL) is not required (since in the absence of a BL, the architect requirement threshold is moot). Figure 7 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.

Many other rationales could exist for households to avoid filing for a building license and file a simplified "Preliminary Statement" instead. However, bunching at the *BL* threshold specifically to be exempt from the architect requirement is irrelevant for units with an initial size h^E in the $[\bar{h} - h_{BL}, \bar{h}]$ interval. Households understand and act in response to the complex interlocked incentives of the *BL* and *architect requirement* thresholds. Indeed, appendix figure C.12 demonstrates that the excess mass of additions 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 (i.e. 170 minus 40) square meters. This implies that bunching of addition sizes at the 40 square meters *BL* threshold is partly driven specifically by the desire to avoid the architect mandate, rather than other hassle costs associated with filing for a building license.

4.5 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.

4.5.1 Sorting of household types across the threshold

I first provide evidence that households sort across the architect requirement threshold alongside characteristics that correlate with their taste for quality, and therefore with their propensity to favor a quantity distortion over the cost of complying with the prescribed level of quality.

In particular, households on either side of the threshold differ substantially by age and income levels. Households who bunch below the threshold tend to be younger, and are more likely to belong to lower socioeconomic status occupations, as shown in figures 8 and 9. Households who bunch below the threshold are also more likely to benefit from government-sponsored and means-tested zero-interest loans (appendix figure C.13), and more likely to be individuals building by themselves rather than resorting to contractors or other external suppliers (appendix figure C.14). All of these indicate a higher marginal utility of income relative to the valuation of architect services. Conversely, "always-takers" households who comply by the regulation by remaining on the immediate 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 10). 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. As shown in appendix figure C.15, The houses immediately below the threshold, which are more likely to correspond to strategic "bunchers", are much more likely to be used as primary homes, rather than second homes, by their owners.[25]

Projects that remain above the threshold and comply with the regulation (compliers and always-takers) reveal their relatively higher valuation of architect services. As documented earlier, I find that houses above the threshold take longer to start construction after receiving an authorization, consistent with the quality constraints delaying the start of a project, but (for the sub-sample where data on completion date are available) do not take longer to complete overall. They are also likely to be more complex or idiosyncratic construction projects, notably by being more likely to involve the demolition of existing elements (appendix figure C.16). On the other hand, average lot area evolves continuously around the threshold (appendix figure C.17).[26]

[25] In unreported results available upon request, I show that they 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 floor space.

[26] Appendix figure C.18 documents bunching in the distribution of the ratio of floor space 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

4.5.2 Spatial sorting at the threshold

Finally, I document that housing units built immediately below the *ART* (in order to avoid the minimum quality standards associated with a larger size) locate in towns and neighborhoods that differ significantly 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.[27] I then compare the characteristics of the municipalities in which units immediately around the threshold are located.

Economies of scale Bunchers are more likely to be located in municipalities with higher housing construction overall (figure 11), and a larger share of bunchers among *other* housing projects (figure 12). The higher level of overall housing construction is indicative of a difference in the aggregate behavior of housing supply in the towns where strategic bunchers live. It suggests the presence of complementarities in housing production between homes located exactly at the size threshold, and of spatial sorting depending on the leniency of local planning authorities in allowing for standardized, "below-threshold" housing construction. By concentrating demand for homes in a narrow band immediately below the ART, the regulation has the unintended effects of enhancing the production of similarly-sized houses with potentially large economies of scale in design and construction. Such production complementarities induced by the spike in demand for homes of a specific size are also consistent with a pattern of historical entry of large homebuilders around the timing of the architect requirement regulation. Two of the largest homebuilders in France, *Maison Bouygues* and *Babeau-Seguin*, were founded respectively in 1978 and 1982; *IGC*, the largest homebuilder in the Southwest of the country, was created in 1979.

Spatial sorting by taste for quality Second, towns in which the bunchers are more likely to be located (those where homes immediately below the 150 square meters threshold are

sides of the *ART*.

[27]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*.

built) 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 appendix figure C.19. 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 floor space, 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 spatial housing segregation introduced by the quality regulation itself.

Importantly, towns corresponding to homes on the right-hand side of the threshold are characterized by higher rents and housing prices (figure 13). 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 appendix figure C.20), but not at the bottom quartile. Towns in which the higher quality units locate also generally exhibit substantially higher population and population density. The pattern of the relationship between town-level average rents and incomes and home sizes is flat on each side of the threshold. This suggests that rather than being driven merely by the resorting of some bunching households from the right to the left side of the *ART*, which would lead to a "dip" exactly at the threshold, the regulation acts as a focal point. This salient watershed delineates two sub-segments of the new home market: a higher-quality, "large homes" segment above the *ART*, and a lower-quality, "small homes" one below.

5 Structural estimation

I parameterize the model of section 3 to structurally estimate the distribution of tastes for, respectively, the quantity of housing services, and the quality added by architects. This allows me to recover an underlying structure of preferences such that optimal decisions closely match the cross-sectional frequency of housing sizes observed in the $ART = 170$ period (2013-2016), to run counter-factual experiments in the model, and to evaluate the welfare cost of the regulation.

Parametric assumptions I assume utility is quasi-linear in the outside good and iso-elastic in housing quantity:

$$u(c,h,A) = c + (\theta^\eta + (1-t)\alpha^\eta A)\frac{h^{1-\eta}}{1-\eta} + t\alpha A \tag{7}$$

The distribution of θ governs tastes for housing quantity. The distribution of α reflects the perceived quality added from using architect services, and t determines whether preferences for quality have a "fixed" or "variable" nature – i.e. to what extent the valuation of architect-built housing scales with the quantity of housing consumed.

For a given taste for quality α, the corresponding marginal buncher (with choices $\bar{h} + \Delta h(\alpha)$, $A^0(\alpha) = 0$ absent the regulation) is indifferent between bunching at $\bar{h}$, or using an architect at interior choice $h_I \geq \bar{h}$. Agents with lower α – who value architect services less – are the most willing to bunch, so the location of the marginal buncher, $\bar{h} + \Delta h(\alpha)$, is decreasing in α: the lower α, the further from the notch are households willing to distort quantity rather than comply with the quality requirement.[28]

I assume that quantity preferences are drawn from a type-I extreme value distribution $F_\theta = \mathcal{F}(\mu_\theta, \sigma_\theta)$. The parameter governing the share of households choosing to use an architect α is drawn from a Frechet distribution with shape and location (s_α, l_α). I also allow for mistakes or "bunching noise" (which allows the shape of the bunching mass to be diffuse to the left of the notch in the data, rather than located exactly at the notch) to come from an exponential distribution with mean λ.

Estimation via method of simulated moments I estimate the model using the simulated method of moments to closely match the observed distribution of housing quantity choices made by households in the data. The main objective is to select (conditional on t) a set of parameters $\Theta = (\eta, \mu_\theta, \sigma_\theta, s_\alpha, l_\alpha, \lambda)$ governing the distributions of θ and α to generate simulation-based moments closely aligned with K key moments from the data, corresponding to frequencies of housing choices for K bins of one square meter in the cross-section for the period

[28] Assuming $\alpha \geq 0$ (meaning the valuation of architect services cannot be negative), the regulation for the "last" marginal buncher with $\alpha = 0$ is akin to a pure "tax notch" of size F. For a constant (inverse) elasticity η, this household's preferred quantity choice is located the furthest away from the notch in the counter-factual distribution, and could be estimated according to the "convergence point" method of Kleven and Waseem (2013).

2013-2016 in the range [60,450]. Since the parametric distributions will give rise to smooth choices in the simulated moments, I follow Carril (2019) in first smoothing the distribution of housing choices in the data using a 10-order polynomial on each side of the threshold, excluding the bunching range [167,169] (see appendix B). The model then selects parameters to fit the smoothed distribution. These smoothed moments are the *target moments*, denoted by m_d. Corresponding *model moments* $m_s(\Theta)$ are created by simulating $N \times s$ observations with the model parameterized by Θ. The estimated parameters are chosen to minimize a standard distance metric:

$$\widehat{\Theta} = \underset{\Theta}{\operatorname{argmin}}(m_d - m_s(\Theta))' W_K (m_d - m_s(\Theta)) \tag{8}$$

where W_K is a $K \times K$ weighting matrix, which is the identity matrix modified linearly to give more weight to bins close to the threshold. Following Einav, Finkelstein, and Mahoney (2018) and Carril (2019), I increase the weights of bins closer to the policy threshold. Specifically, I subtract a constant amount of 1/K for each moment away from the threshold.

Identification All parameters are jointly estimated; however, certain data moments help identify specific parameters. The location μ_θ and scale σ_θ are governed by the overall position and shape of the distribution of optimal housing space in the absence of an architect mandate, which are in turn pinned down by moments well above and below the policy threshold.

The frequency moments just around the policy threshold identify the (inverse) elasticity of utility with respect to housing consumption η – which impacts the number of bunchers; and the shape s_α and location l_α of the taste for quality α (which govern the compliers and always-takers share). In addition, the moments below but not exactly at the policy threshold $\bar{h}$ identify the magnitude of the mean bunching noise λ.

The cost per unit of housing space p_H is normalized to 1. In addition, I calibrate F so that the change in average cost between the policy threshold and the bin right after it is around 9%. Incomes (which are only relevant to scale aggregate welfare effects) are calibrated so that households spend 30% of their income on housing costs on average.

Model fits and counter-factuals Table 2 summarizes the estimated parameters, depending on the calibration of t, which governs the "fixed" or "variable" nature of preferences for quality. Appendix figure C.21 displays the fit of the model for various choices of t, showing that the model replicates well the overall density of preferred housing quantity choices, and the shape and scale of the large bunching mass immediately below the threshold during the $ART = 170$ period. As shown in figure C.22, the model is also informative about unobservable outcomes, such as the average cost of construction or the share of households using architects (both in the equilibrium with regulation and in the counter-factual without it). Overall, the model implies that the regulation substantially distorts quantity and quality choices, and that the welfare loss from distortions is larger among "compliers" who distort quality choices than among bunchers who distort quantities. Intuitively, compliers are "infra-marginal" and unwilling to distort quantity below the notch; they must therefore suffer the high cost of paying for an architect despite their low private valuation for their services.

I also show that the model performs well in replicating untargeted counter-factual moments, and in particular in quantitatively matching the consequences of tightening the *ART* to 150 after 2017 (see figure 14). As shown in the figure, only a relatively low value of t (suggesting preferences for quality strongly correlated with preferences for quantity) is able to replicate not only the movement in the bunching mass from the old to the new threshold, but also the quantitatively large share of "switchers" at the former *ART* (agents who would bunch under the 170 threshold, but comply with the regulation under the new threshold of 150). Intuitively, when preferences for quality are variable in nature, households further away from the new threshold are more likely to have sufficiently high tastes for quality that they prefer complying with the regulation by using the services of an architect, rather than distorting quantity.

The model also allows me to estimate the housing consumption and welfare consequences of entirely removing the regulation. Appendix figure C.23 displays the counterfactual housing consumption distribution absent the regulation, by deciles of preferences for quality. Former bunchers (between 1.7 and 1.9% of all households) would increase housing consumption by 5.5 to 7% on average, in the absence of the rule, depending on the value of t. Using the implied share of compliers (ranging from 0.3 to 0.9% of all households) and the estimated welfare loss in the model, I can compute the required positive aesthetic externality of architect-built houses that would render the policy welfare-neutral. These estimates are summarized in table 3. Overall, across calibrated values of t, the policy would be welfare-improving if spending on architects by additional compliers yields positive externalities (e.g. through un-internalized improvements in safety or pecuniary externalities on the value of neighboring houses) of more than 4 to 8 cents per euro spent on architect services.

6 Discussion and conclusion

To what extent and how quality regulations impose costs on new housing development, and affect the quantity of new housing consumed, its characteristics, and its spatial allocation? This paper makes progress on this question, heretofore hindered by the absence of data and causal identification. A simple conceptual framework shows that whether and how much households reduce consumption or distort quality to circumvent the "notched" increase in regulatory stringency can be used to reveal the cost of regulation. Empirically, static and dynamic bunching methods demonstrate that the rule indeed distorts the intensive margin of dwelling size, as well as the decision to expand existing constructions or undertake new projects. I quantify the additional charge associated with regulatory compliance, and evidence patterns of consumer sorting along the quality-quantity trade-off. These regularities suggest that the discrete threshold for regulatory enforcement acts as a salient watershed, segmenting sub-markets across space and quality ladder.

Regulations intend to improve the aesthetic quality of new single-family homes beyond what the *laissez-faire* equilibrium would yield. If housing quality has an external amenity value, households would under-consume in the absence of the regulation. However, there could be equity or efficiency reasons for "attribute basing" – i.e. only applying the architect mandate for dwellings above a size threshold. Forcing all construction to be of high-quality, in the absence of a compliance trading system, could potentially generate inefficiently heterogeneous compliance costs. If such costs are indeed systematically higher for small-scale constructions (for example because of fixed hassle costs), or if the externality is size-dependent, making quality mandates only applicable to large-scale houses could be more efficient than applying it to everyone. Alternatively, households building smaller houses may have lower incomes, motivating the exemption by distributional motives.

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 induced to consume a smaller quantity and more standardized housing by bunching below the threshold. The concentration of demand in a narrow range below the threshold leads to large production complementarities and potential economies of scale. Regulating housing quality thus leads to substantial quantity distortions for newly built units, and, given the durable nature of housing structures, temporary changes in regulatory norms have long-lasting effects on housing consumption, spatial sorting, and inequality.

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Main tables

Polynomial	Upper threshold of manipulation range h_U			
	180	185	190	195
B_b				
7	7,410.3	7,192.3	7,201.8	7,360.4
	(185.9)	(188.2)	(189.5)	(190.14)
8	12,023.6	12,020.7	12,189.0	12,409.4
	(189.19)	(192.75)	(194.75)	(195.74)
9	11,693.6	11,546.7	11,551.9	11,593.2
	(187.31)	(190.23)	(191.49)	(191.61)
10	12,958.1	12,924.7	13,065.0	13,225.9
	(186.93)	(191.27)	(194.11)	(195.1)
$\widehat{b}_1$				
7	5.07	4.82	4.83	5.02
	(0.15)	(0.15)	(0.15)	(0.16)
8	13.67	13.66	14.40	15.53
	(0.39)	(0.42)	(0.47)	(0.55)
9	11.61	11.18	11.19	11.32
	(0.28)	(0.28)	(0.29)	(0.3)
10	15.84	15.68	16.39	17.33
	(0.43)	(0.46)	(0.53)	(0.6)

Table 1: **Estimated bunching mass, polynomial fit, 2013-2016**

Note: The statistics in the table are estimated using a flexible polynomial as the counterfactual distribution. The polynomial used is estimated according to equation 3, varying the order K of the polynomial and $h_U = \{180, 185, 190, 195\}$. The actual distribution of housing space between 2013-2016 is capped at 41 and 400. As outlined in equation 3, the estimated bunching mass is the difference between the counterfactual and actual distributions for the range of housing space between $h_L = 160$ sq.m. and $\bar{h}$ sq.m, inclusive. Standard errors are computed via bootstrap with B=100. $\widehat{b}_1$ is the difference between the housing space bin of the marginal buncher and the policy threshold $\bar{h} = 169$. The marginal bunching response is estimated so that the estimated bunching mass $B(\bar{h})$ approximates the missing mass above the policy threshold.

Table 2: Estimated structural parameters via SMM

Parameter	Estimate (s.e.)					
F= 19.094	t=0.90	t=0.75	t=0.5	t=0.25	t=0.10	t=0.0
(Inverse) Elasticity of utility wrt housing space (η)	0.208	0.336	0.430	0.530	0.588	0.625
	(0.001)	(0.001)	(0.001)	(0.0005)	(0.0005)	(0.0006)
Location housing quantity preference distr. θ (μ_θ)	101.16	102.47	103.29	103.42	103.95	103.94
	(0.09)	(0.093)	(0.089)	(0.088)	(0.086)	(0.081)
Scale housing quantity preference distr. θ (σ_θ)	23.80	24.94	25.78	26.65	27.19	27.46
	(0.075)	(0.077)	(0.069)	(0.066)	(0.064)	(0.063)
Shape housing quality preference distr. α (s_α)	0.984	1.543	3.211	5.136	7.041	8.364
	(0.01)	(0.018)	(0.045)	(0.092)	(0.156)	(0.203)
Location housing quality preference distr. α (l_α)	5.412	1.326	0.080	0.003	0.002	0.003
	(0.057)	(0.025)	(0.004)	(0.001)	(0.001)	(0.001)
Mean bunching noise λ	1.338	1.388	1.391	1.106	1.100	1.110
	(0.038)	(0.038)	(0.04)	(0.033)	(0.032)	(0.032)
SSE ($\times 10^{-5}$)	2.563	2.707	2.809	3.132	3.340	3.448
Δ Avg. Construction Cost	9.0%	9.0%	9.0%	9.1%	9.2%	9.4%

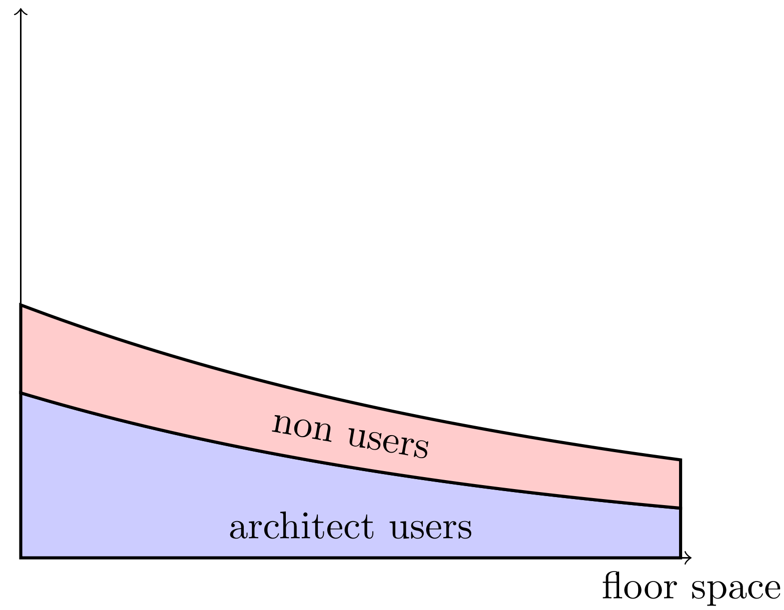
Note: This table summarizes estimated parameters of the model discussed in the previous section when F is calibrated, for various calibrated values of t. To compute the simulated moments, I simulate 30,000 households in a distribution, keeping households with housing space $\geq$ 60 square meters. I then take the average of the simulated moments across 20 distributions. These sets of estimates minimize distances between simulated moments and data moments. The weighting matrix used puts more weight on bins near the policy threshold. Standard errors are in parentheses, computed using the asymptotic variance-covariance matrix. When F = 19.094, the change in average construction cost approximates 9%.

Table 3: Model-implied spillovers from using an architect for policy to be welfare-neutral*

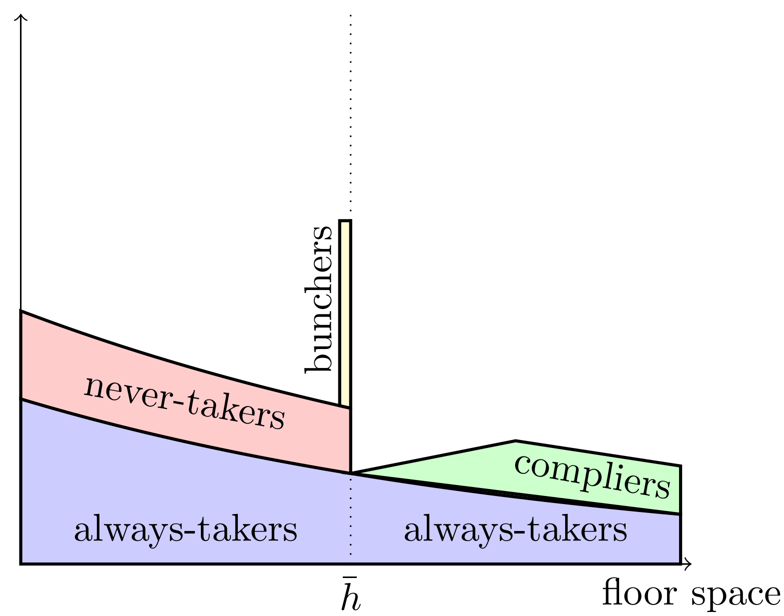
	t=0.90	t=0.75	t=0.5	t=0.25	t=0.10	t=0.0
Spillovers from €1 spent on an architect (cent)	5.53	7.29	8.17	6.01	4.91	4.47
Spillovers from €1 of construction cost (cent)	0.39	0.55	0.63	0.49	0.41	0.38
Share of compliers	0.26%	0.41%	0.52%	0.66%	0.79%	0.89%

Note: This table summarizes the model-implied spillovers from using an architect required for the policy to be welfare-neutral. The measure of spillovers per complier is estimated as the change in total welfare, divided by the number of compliers.

Main figures

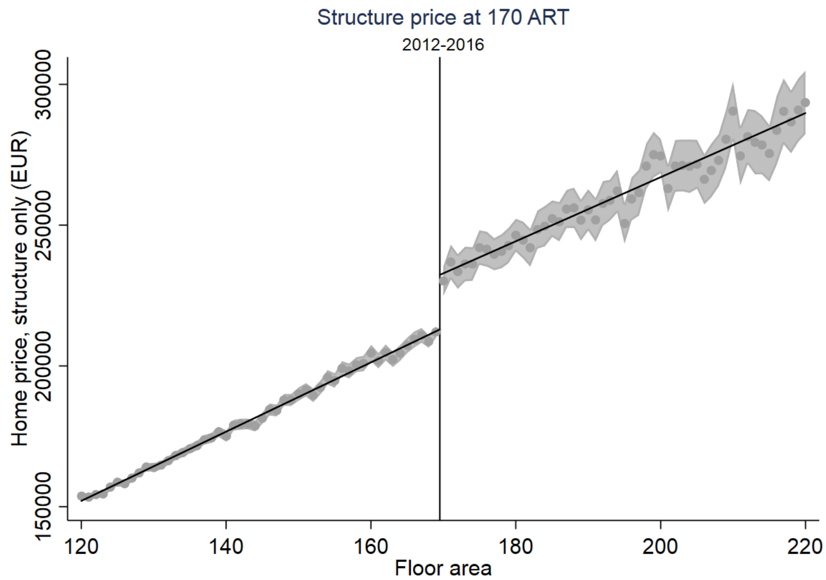


(a) Counter-factual case

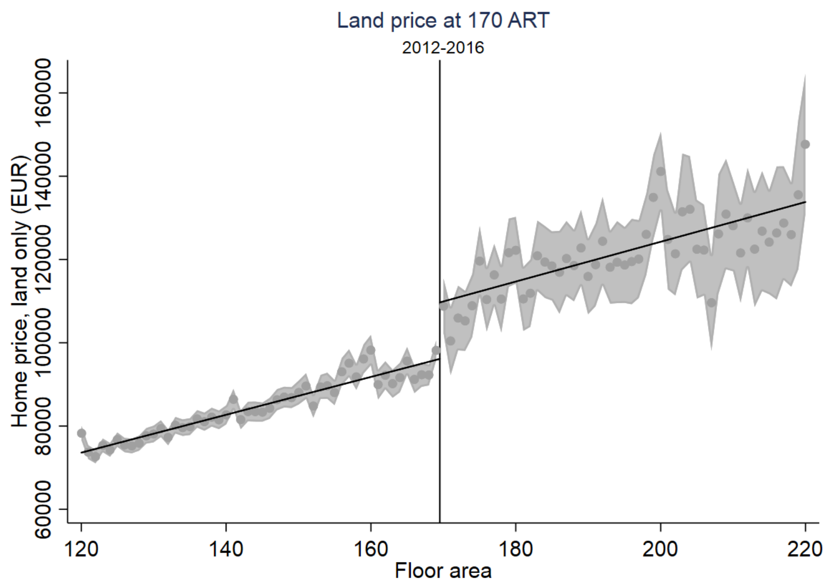


(b) With the attribute-based regulation

Figure 1: **Stylized description of the quantity-quality trade-off model outcomes** The figure describes graphically the constrained choices under regulation 2 (bottom panel) and heterogeneous incentives to bunch at the *ART* for all types of households, depending on whether their unconstrained choices absent the regulations (top panel) would involve the use of an architect or not, as described in section 3. *Always-takers* would use an architect even absent the regulation. *Never-takers* would not use one and not exceed the ART absent the regulation and are also unaffected. Affected agents (who would not use an architect but locate above $\bar{h}$ absent the regulation) are split between *compliers*, who increase quality beyond their preferred level and remain above the *ART*, and *bunchers*, who reduce quantity to $\bar{h}$.

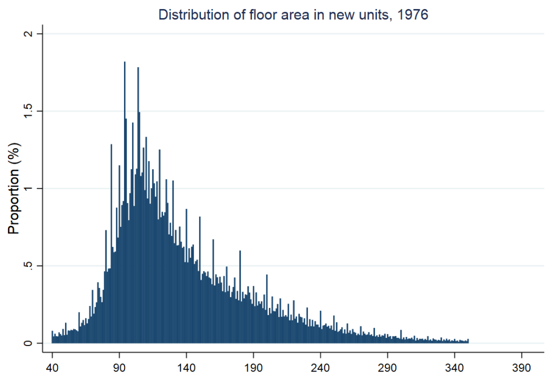


(a) Structure costs

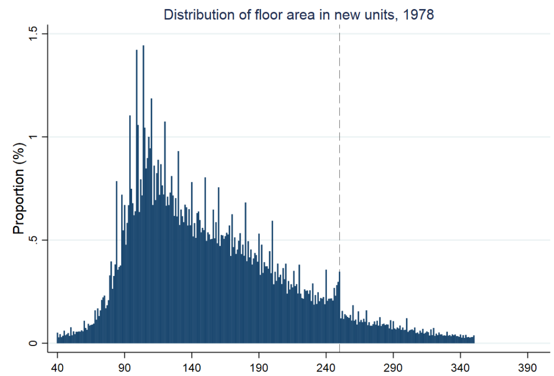


(b) Land costs

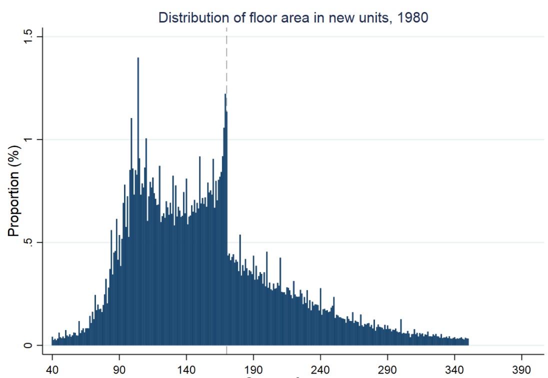
Figure 2: **Construction cost and land costs for new units, 2012-2016** The figure plots a binned scatter plot of the construction cost (only including structure price) of new units against their floor space (*SDP*) for new units with approved building licenses in the EPTB data. Panel (a) plots the discontinuity of structure costs at the 170 square meters mark in the 2012-2016 data, while panel (b) plots the discontinuity in land costs at the 170 square meters threshold. The raw data are only adjusted for year fixed effects to account for nationwide inflation in construction costs across years.



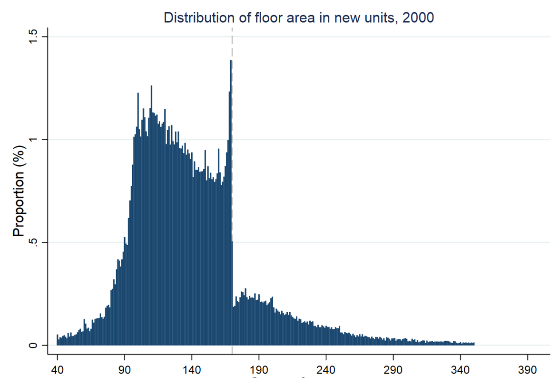
(a) 1976, no ART



(b) 1978, 250 sq.m. ART



(c) 1980, 170 sq.m. ART



(d) 2000, 170 sq.m. ART

Figure 3: **Distribution of new unit size, selected years** The figure plots the distribution of floor space (*SHON*) for new units for selected years. The dashed vertical line indicates the exemption level for the architect requirement (when in force). In particular, panel (a) plots the distribution in 1976, before the implementation of any 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 the excess bunching mass over a twenty year periods, but also the substantial increase over time in the magnitude of the missing mass above the threshold.

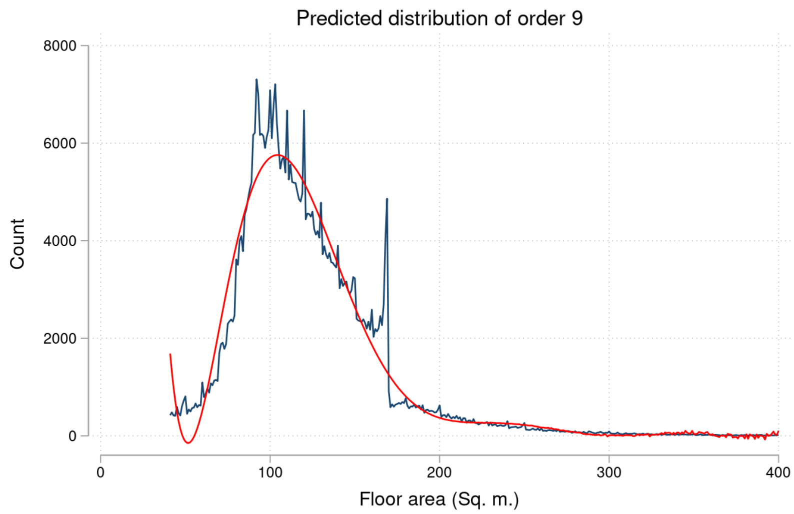


Figure 4: **Distribution of new unit size, 2013-2016, polynomial fit approach** The figure plots the distribution of the floor space (*SDP*) of new units with approved building licenses from 2013 to 2016 in the Sit@del data. The blue line is the underlying distribution of housing space between 2013-2016, capped at 41 and 400. The red line is a 9th-order polynomial fit, derived according to equation 3.

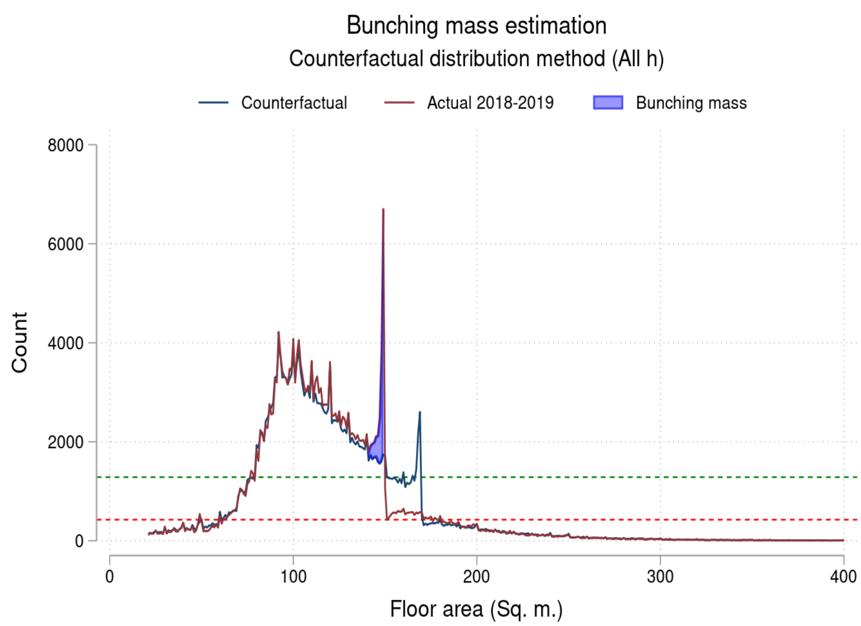


Figure 5: **Distribution of new unit size, placebo notch approach** The figure plots the distribution of the floor space (*SDP*) of new units with approved building licenses from 2018 to 2019 in the Sit@del data. The ART was lowered to 150 square meters in 2017. The counterfactual distribution is the rescaled 2013-2016 distribution of new housing space constructed, as described in section 3. The estimated bunching mass $B_b = N(h) - \widehat{N}(h)^{Ctf}$ is illustrated by the blue area. The red dashed line is the actual level of the density immediately above the new notch, corresponding to an estimate of the number of "always-takers" at 150, and the green dashed line is the counter-factual estimated level at 150 from the shape of the 2013-16 distribution.

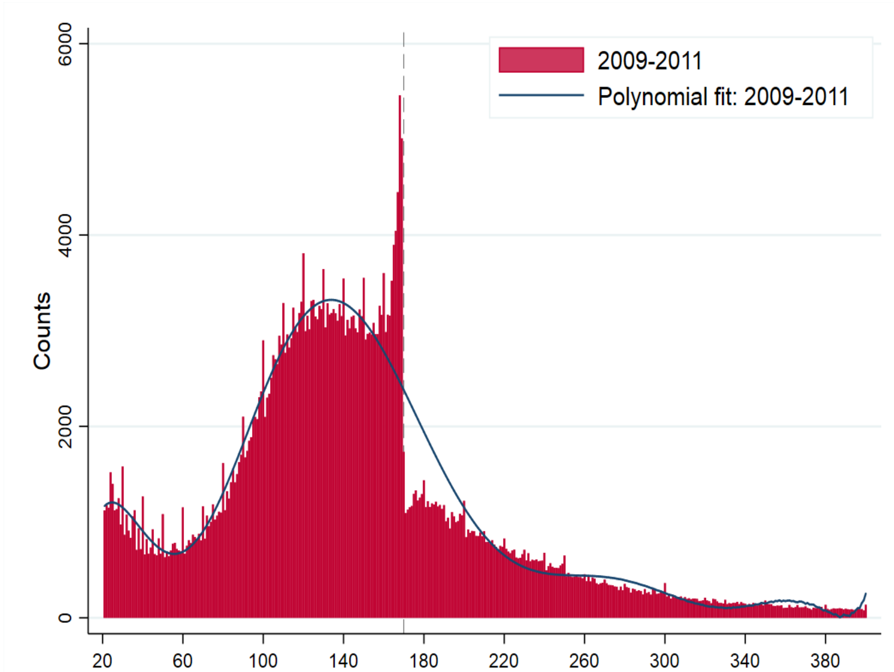


Figure 6: **Distribution of the size of completed units for extensions, 2009-2011** The figure plots the distribution of the floor space (*SHON*) of completed units after extension projects, from 2009 to 2011 in the Sit@del data. The histogram corresponds to the counts of units for which the size of the completed, post-extension dwelling falls in each square meter bin. The solid line plots a polynomial fit of order 10 excluding the manipulation range, according to the methodology defined in section 3.

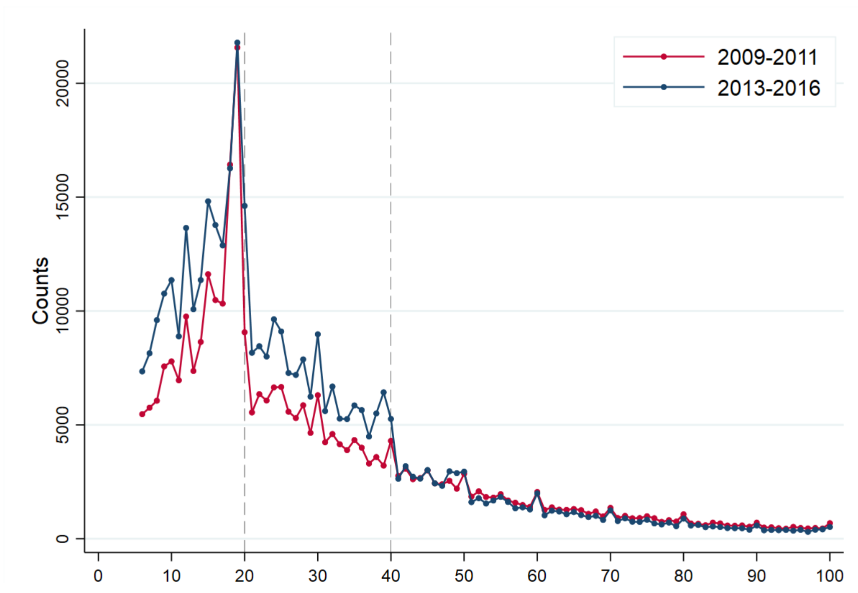
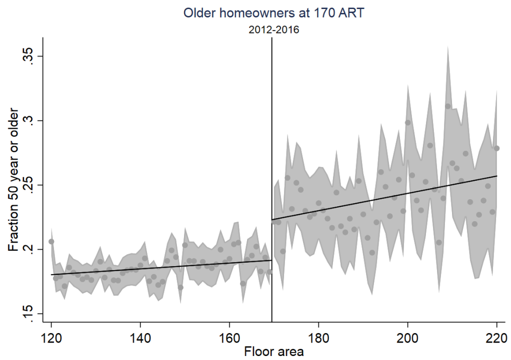
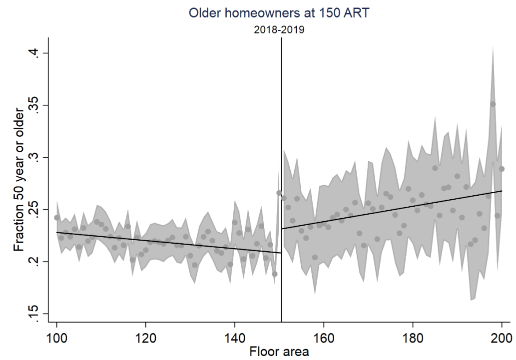


Figure 7: **Distribution of extension sizes: bunching at the building license thresholds** The figure plots the distribution of the floor space of extensions from 2009 to 2011 (red line), and from 2013 to 2016 (blue line) in the Sit@del data. The sharp bunching at 20 square meters (and smaller bunching at 40 square meters after 2012) indicates the preference 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 PS instead of a BL constitutes an alternative avoidance mechanism to avoid meeting the architect requirement conditions when the completed size exceeds the ART h^*.

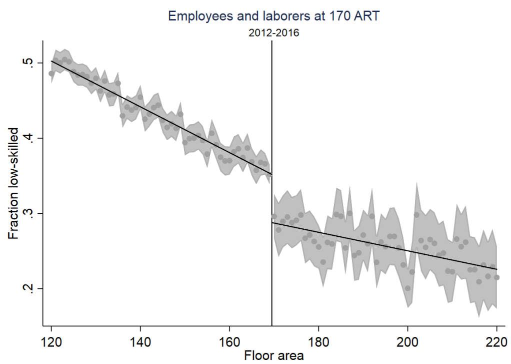


(a) 2012-2016, 170 sq.m. ART



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

Figure 8: **Share of older households** The figure plots the share of households with a head of household aged 50 or more against the floor space 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 9: **Share of low-skill households** The figure plots the share of lower-skill socio-economic status (employees and blue-collar workers) households against the floor space of new units, before and after the threshold was lowered to 150 square meters, in the EPTB data.

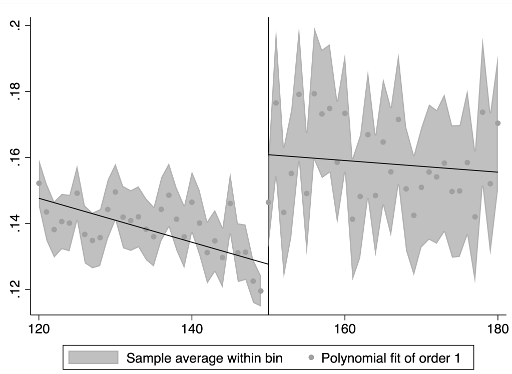


Figure 10: **Out-of-town households** The figure plots the share of filers who live in a different French province (*departement*), for each bin of floor space of new units, after the threshold was lowered to 150 square meters, in the EPTB data.

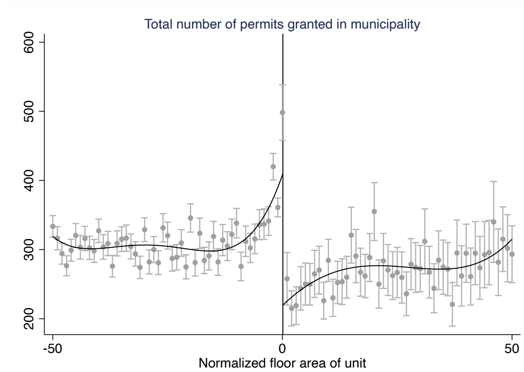


Figure 11: **Total construction in municipality** The figure plots the total number of projects in the municipality (excluding the project itself), for each bin of floor space of new units, pooling all post-2013 data in the Sitadel data and normalizing the threshold to zero.

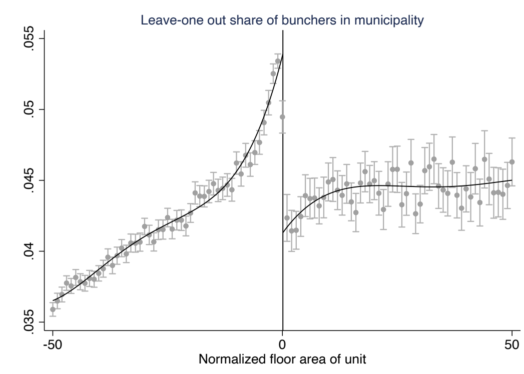


Figure 12: **Share of bunchers in municipality** The figure plots the share of *other* projects in the municipality with a size immediately below the threshold (excluding the project itself), for each bin of floor space of new units, pooling all post-2013 data in the Sitadel data and normalizing the threshold to zero.

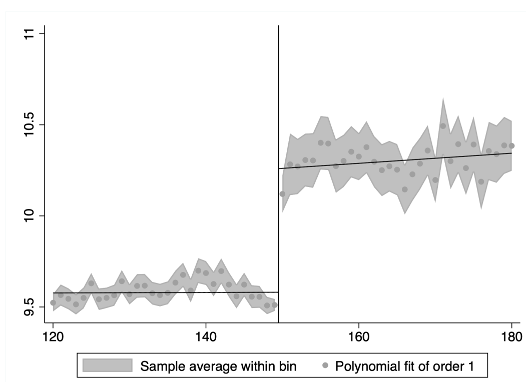
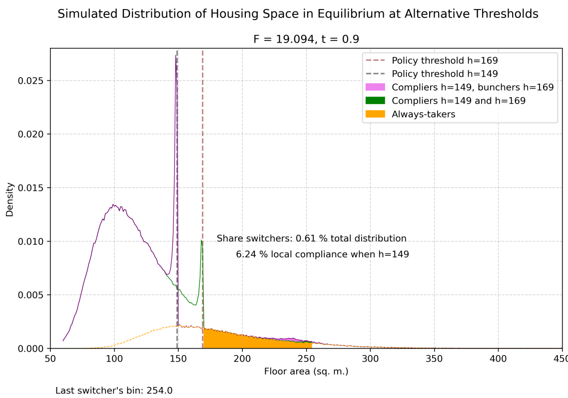
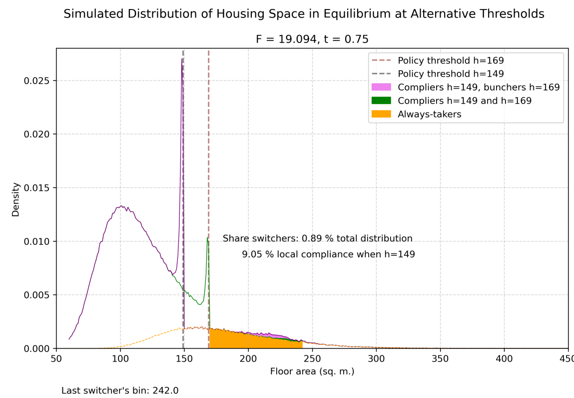


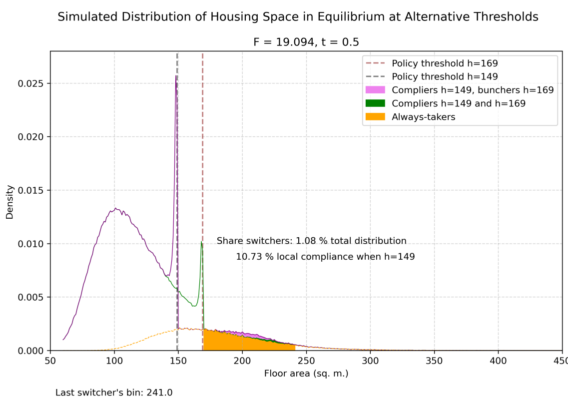
Figure 13: **Town average rents** The figure plots the average rents per square meters in the towns for each bin of floor space of new units, after the threshold was lowered to 150 square meters, in the Sitadel and *Observatoire des loyers* data.



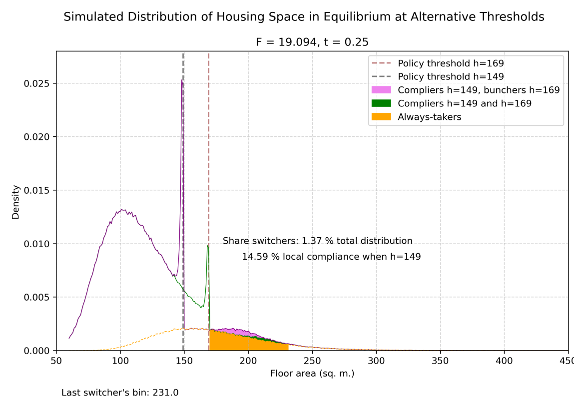
(a) t=0.90



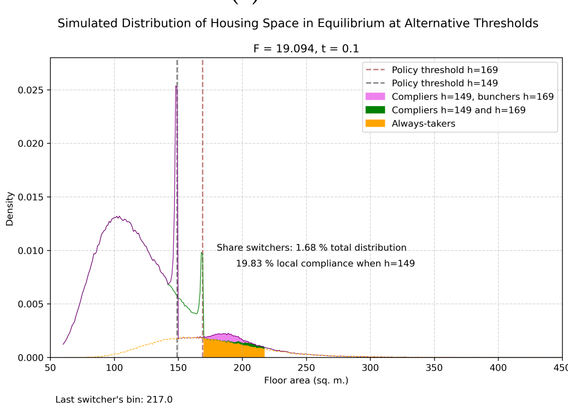
(b) t=0.75



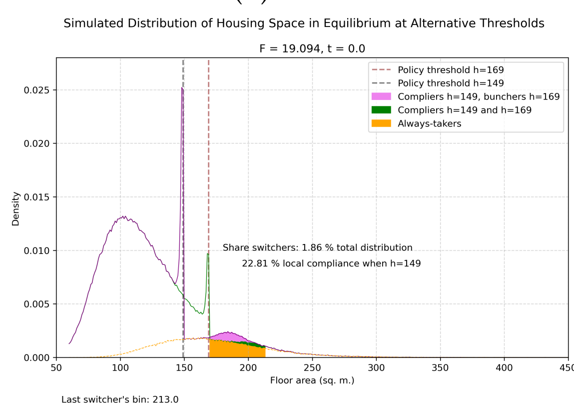
(c) t=0.50



(d) t=0.25



(e) t=0.10



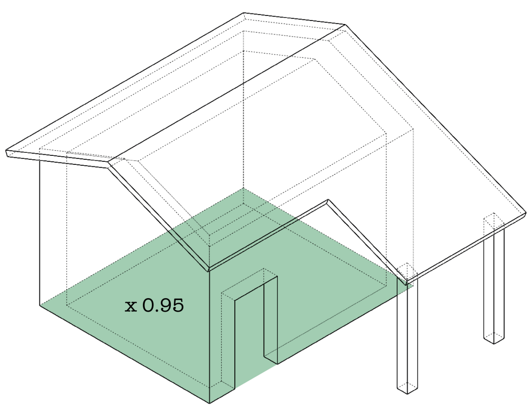
(f) t=0.0

Figure 14: **Model simulation of tightening the *ART*** This figure plots the simulated distributions (colored lines) around the policy thresholds ($\bar{h} = 169$) and ($\tilde{h} = 149$) using structural parameters estimated via the method of simulated moments. The set of estimated parameters used is $\widehat{\Theta}$ where $F = 19.094$. I simulate 30,000 households in a distribution and take the average of the simulated moments across 20 distributions. The weighting matrix used gives more weight to housing space bins near the policy threshold.

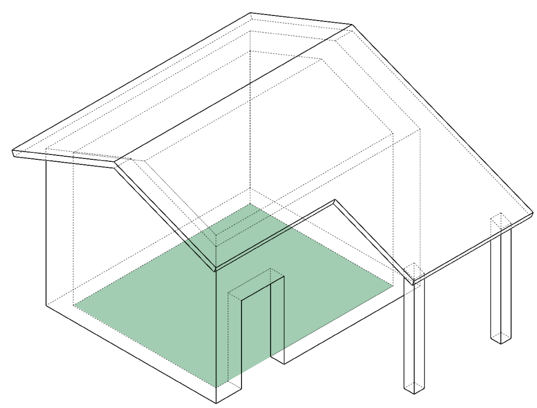
Online Appendices - for online publication

A Institutional background: addendum

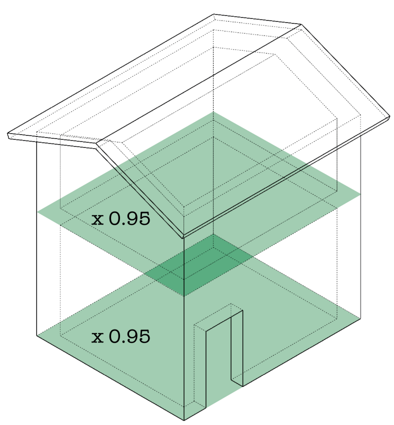
The March 2012 reform led to the replacement of the *SHON* (computed from the outside of external walls) by the *SDP*, computed from the inside of external walls. This led to a decrease of 5 to 12 percent of the measured square footage for the same new construction, and therefore implied that the architect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



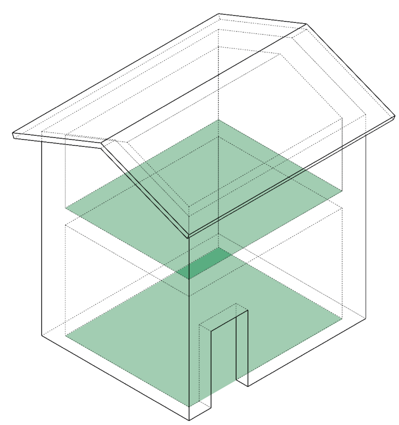
(a) *SHON*, single-story house



(b) *SDP*, single-story house



(c) *SHON*, multi-story house

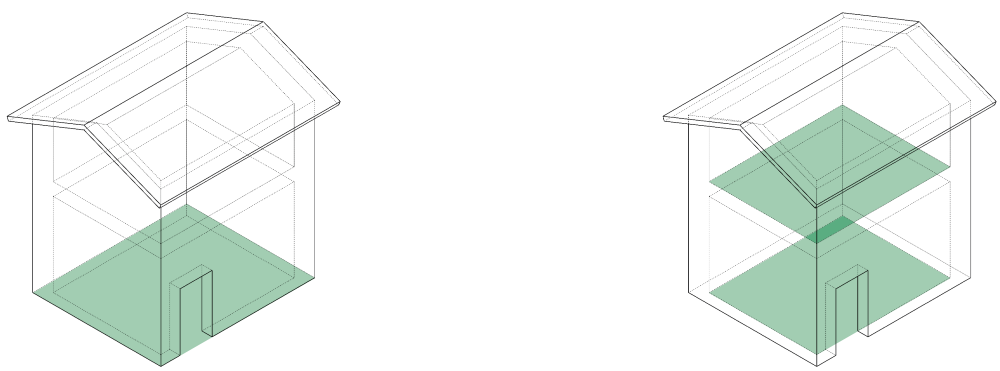


(d) *SDP*, multi-story house

Figure A.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) compare 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.

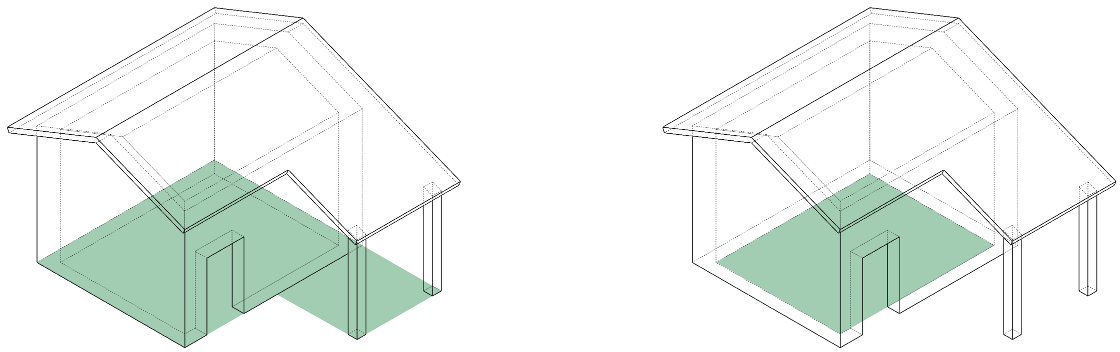
In the simplest case of a single-story square home, illustrated in figure A.1, with external walls of thickness ε and an *SDP* of side L, the *SDP* would be: $SDP = L^2$ while the corresponding *SHON* would be: $SHON = 0.95 \times (L + 2\varepsilon)^2$. Thus the *SDP* was smaller than the *SHON* as long 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.

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.2: **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

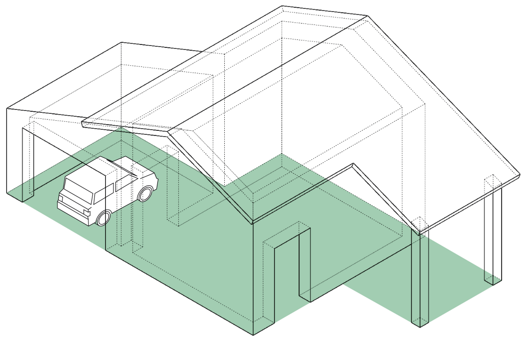
Figure A.3: **Comparison of the *EAS* and *SDP* for a single-story house** The figure compares the March 2012 definition of square footage (*SDP*) to the March 2012 definition of footprint (*EAS*) used in the dual architect requirement threshold test. Panel (a) plots the *EAS* of a single-story home, 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.2 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.3), 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.

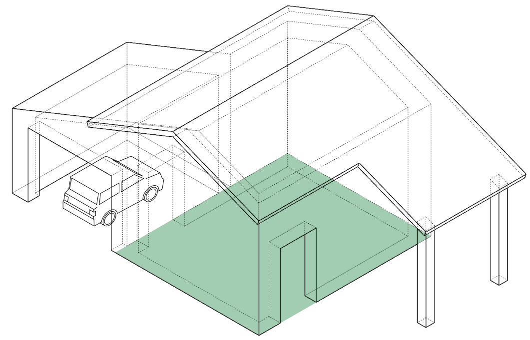
In May 2012, the law was rectified again. In the dual test, the *EAS* was replaced by the so-called *EAS-CSDP*[29]. The *EAS-CSDP* included only the "footprint" of the elements of a structure with a "floor area" (*SDP*), therefore excluding balconies or garages (see figure A.4). After the May 2012 modification, 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.[30]

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

[30] 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.4: **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.

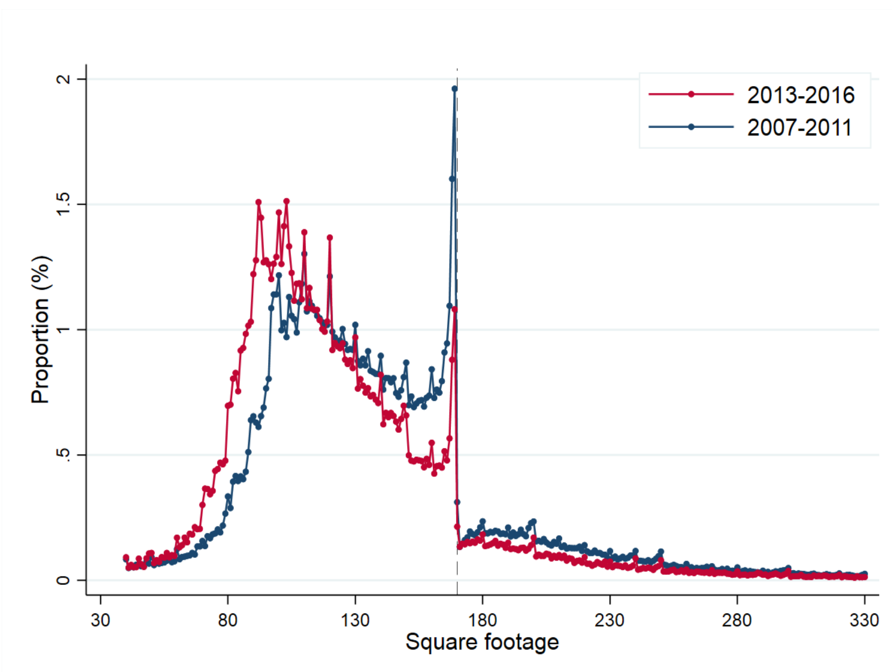
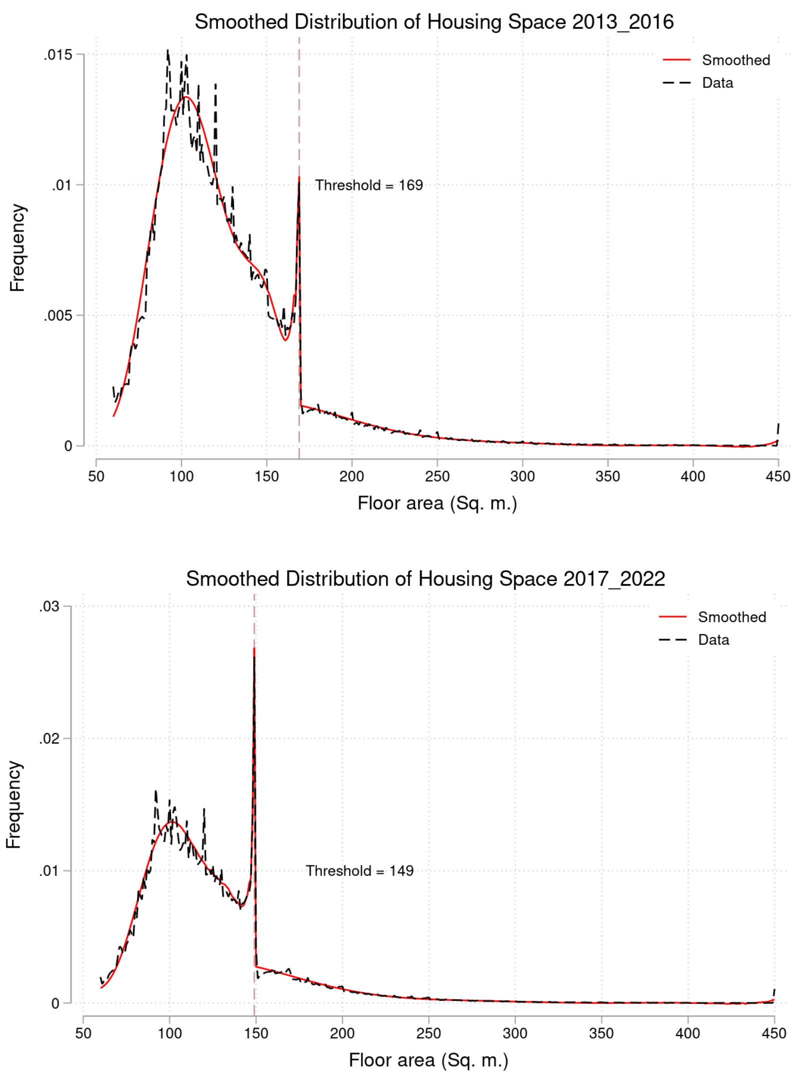


Figure A.5: **Impact of the 2012 change in definition on the size distribution for new units** The figure plots the distribution of the square footage (*SHON*) of new units with approved building licenses from 2007 to 2011 (blue line), and the floor area (*SDP*) of new units built from 2013 to 2016 (red 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*.

B Smoothing of Housing Space Frequency Moments

Following Carril, 2019, I smooth out spikes at round numbers in the real data, which the simulated distribution of housing space would not otherwise be able to match. In addition, since my objective is to model the bunching behavior around the policy threshold, it is reasonable to focus on matching data moments around the notch. The housing space distribution will be smooth at all moments except at the policy threshold.

Figure B.1: Smoothed data moments



I smooth out the housing space distribution by estimating two regressions, one above and one below the notch. Let n_h be the number of houses in bin $b \in 60, 450$ and $T = 5, 10$.

The regressions to be estimated take the form

$$n_h = \sum_{p=1}^{P} \beta_p h^p + \sum_{t \in T} \zeta_t \mathbb{I}\{\frac{h}{t} \in \mathbf{N}\} + \sum_{k=0}^{2} \gamma_k \mathbb{I}\{h = \bar{h} - k\} + \varepsilon_h \tag{9}$$

for $h = [60, 169]$, and for $h = [170, 450]$

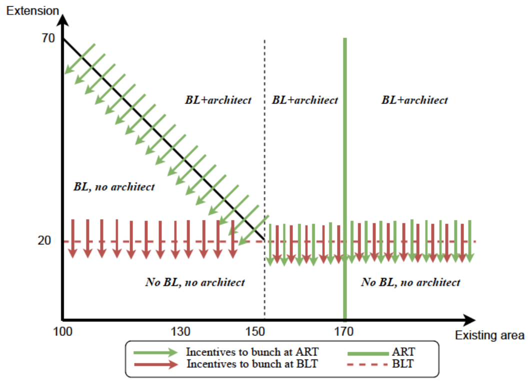
$$n_h = \sum_{p=1}^{P} \beta'_p h^p + \sum_{t \in T} \zeta'_t \mathbb{I}\{\frac{h}{t} \in \mathbf{N}\} + \varepsilon'_h \tag{10}$$

where the first summation is a P-order polynomial and the second is a vector of dummies for multiples of $t \in T$. I select $P = 10$ since this polynomial matches actual moments well, especially around the notch. As in Carril, 2019, I take the prediction from these the two regressions, leaving out the contribution from the dummies for multiples of round numbers. The smoothed distributions above and below the policy threshold are then adjusted by a fixed factor so that the number of observations in the smoothed distributions match that of the underlying housing space data. Specifically,

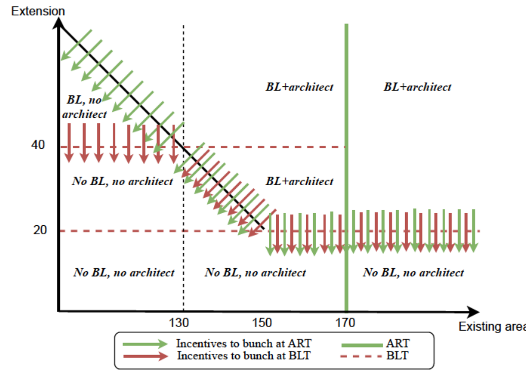
$$\hat{n_h}^{smoothed} = \begin{cases} \hat{n_h}^{pred} \frac{\sum_{h=60}^{169} n_h}{\sum_{h=60}^{169} \hat{n_h}^{pred}} & \text{if h} \in 60, ..., 169 \\ \hat{n_h}^{pred} \frac{\sum_{h=170}^{450} n_h}{\sum_{b=70}^{450} \hat{n_h}^{pred}} & \text{if h} \in 170, ..., 450 \end{cases} \tag{11}$$

where $\hat{n_h}^{pred}$ represents the predicted frequency counts. I obtain the set of simulated moments by normalizing this smoothed distribution. Figure B.1 plots the actual data moments and the smoothed data moments.

C Additional figures

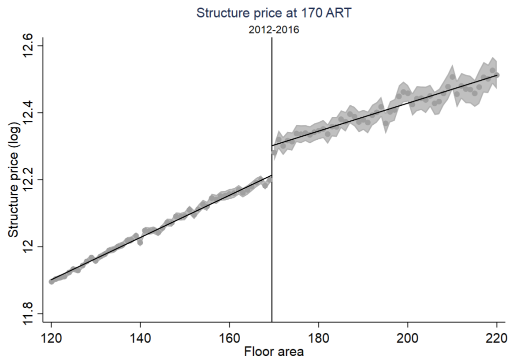


(a) Non-urban areas

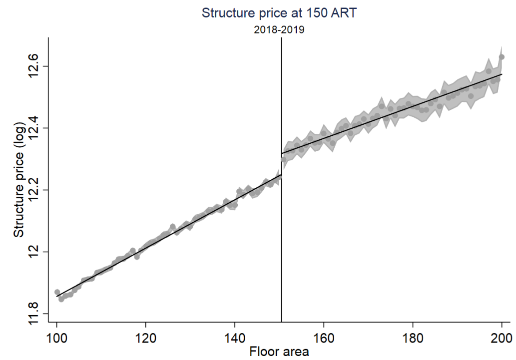


(b) Urban areas

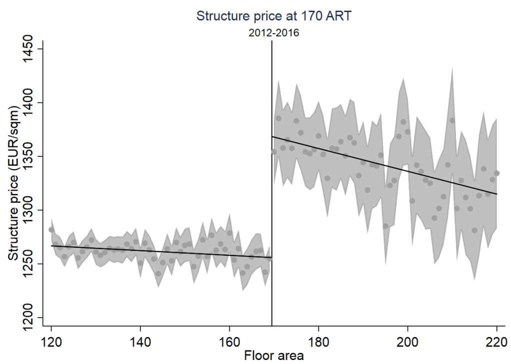
Figure C.1: **Incentives for additions to existing units, 2012-2017** The figure describes graphically the incentives to bunch the size of the addition to an existing home either at the *building license* threshold $\bar{h}$, or at exactly the difference between the *ART* h^* and the existing size h^E, 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*.



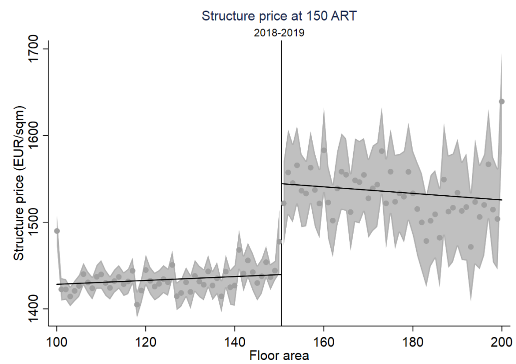
(a) 2012-2016, 170 sq.m. ART



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

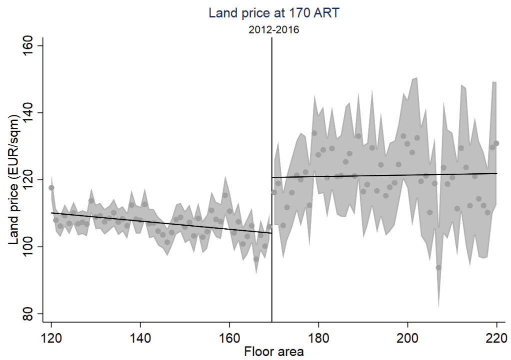


(c) 2012-2016, 170 sq.m. ART

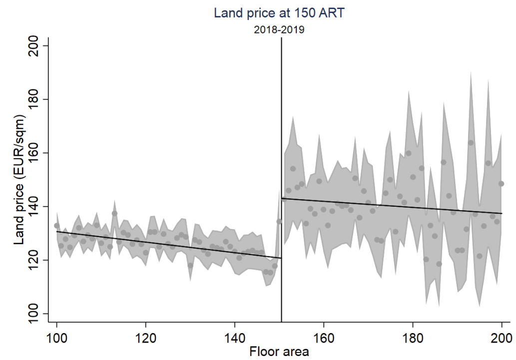


(d) Post-2018, 150 sq.m. ART

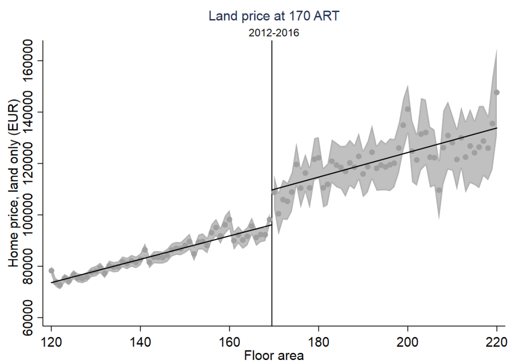
Figure C.2: **Construction cost for new units** The figure plots a binned scatter plot of the construction cost (only including structure price) of new units against their square footage (*SDP*) for new units with approved building licenses in the EPTB data. Panel (a) plots the discontinuity in log points 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.



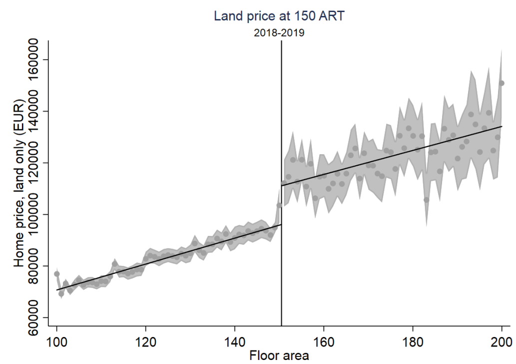
(a) 2012-2016, 170 sq.m. ART



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

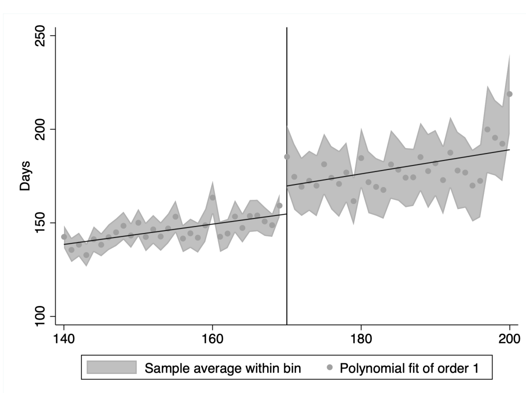


(c) 2012-2016, 170 sq.m. ART

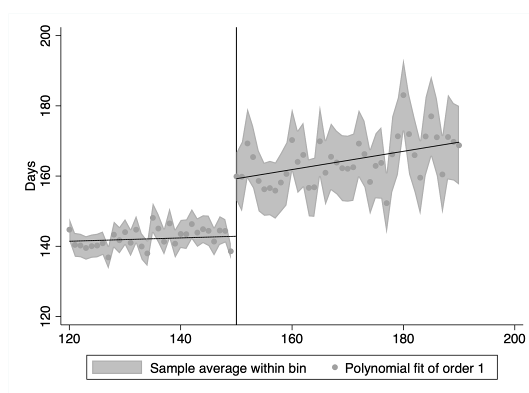


(d) Post-2018, 150 sq.m. ART

Figure C.3: **Land prices for new units** The figure plots a binned scatter plot of the cost of land for new units against the square footage of the structure (*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 (of structure) 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.

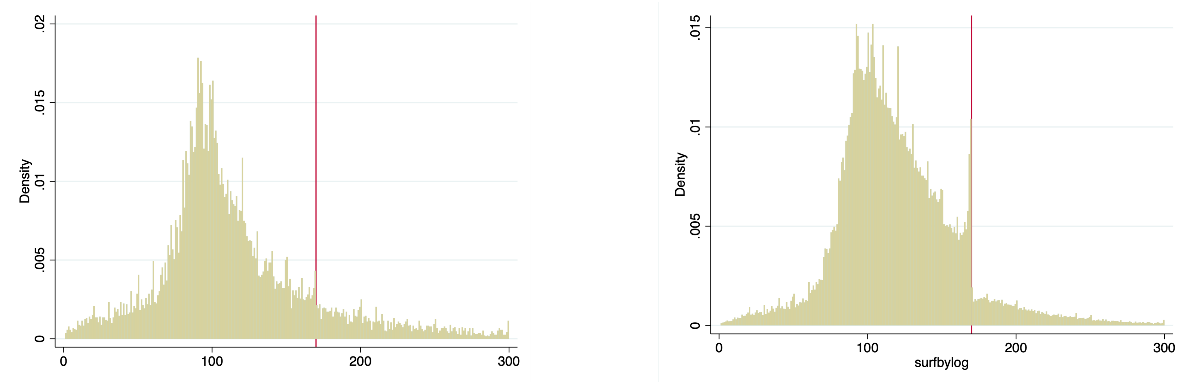


(a) 2012-2016, 170 sq.m. ART



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

Figure C.4: **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.



(a) Placebo: Juridical persons

(b) Treated: Natural persons

Figure C.5: **Distribution of the size of newly built units, 2013-2016, for placebo and treated units** The figure plots the distribution of the square footage (*SHON*) of new units built, respectively, by juridical persons (the "placebo", for whom no size-based exemption exists) in panel (a), and by natural persons (the "treated" 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.

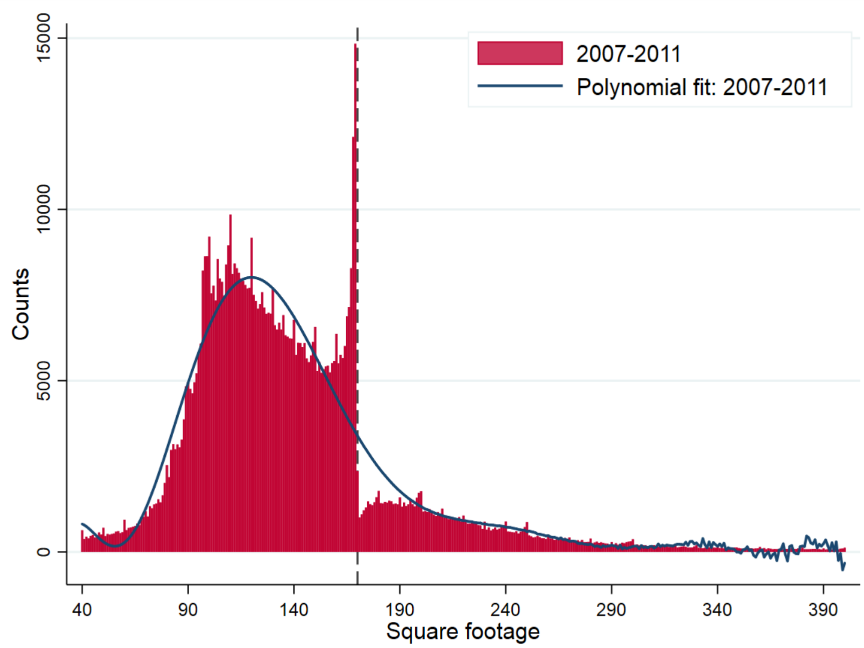


Figure C.6: **Distribution of the size of newly built units, 2007-2011** The figure plots the distribution of the square footage (*SHON*) of new units with approved building licenses from 2007 to 2011 in the Sit@del data. The histogram corresponds to the counts of units in each square meter bin, while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

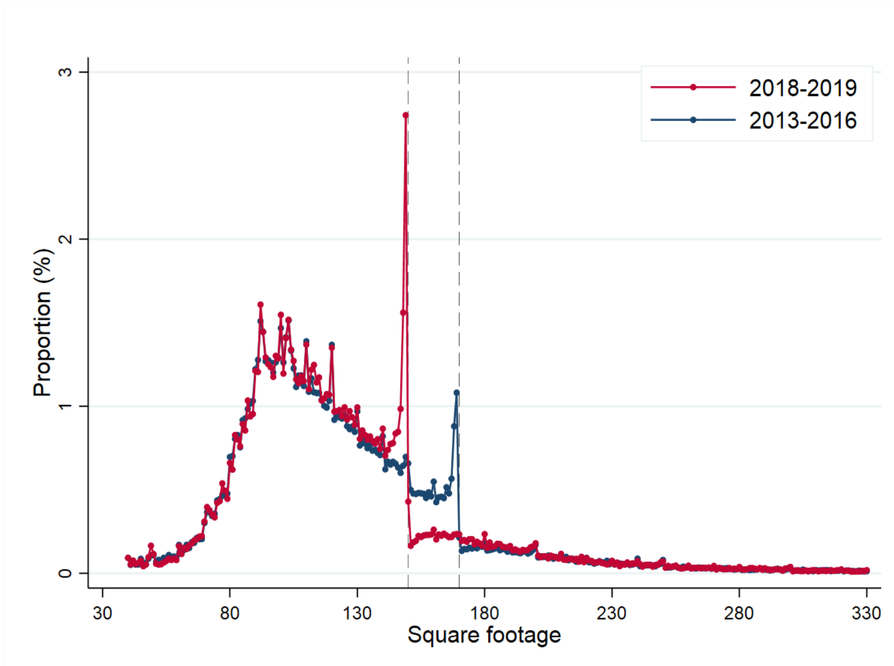


Figure C.7: **Distribution of the size of newly built units, 2017 reform** The figure plots the distribution of the square footage (*SDP*) of new units with approved building licenses from 2018 to 2019 (red line), and from 2013 to 2016 (blue line) in the Sit@del data. The ART was lowered to 150 square meters in 2017, down from its earlier value of 170 square meters, as described in 2.1.

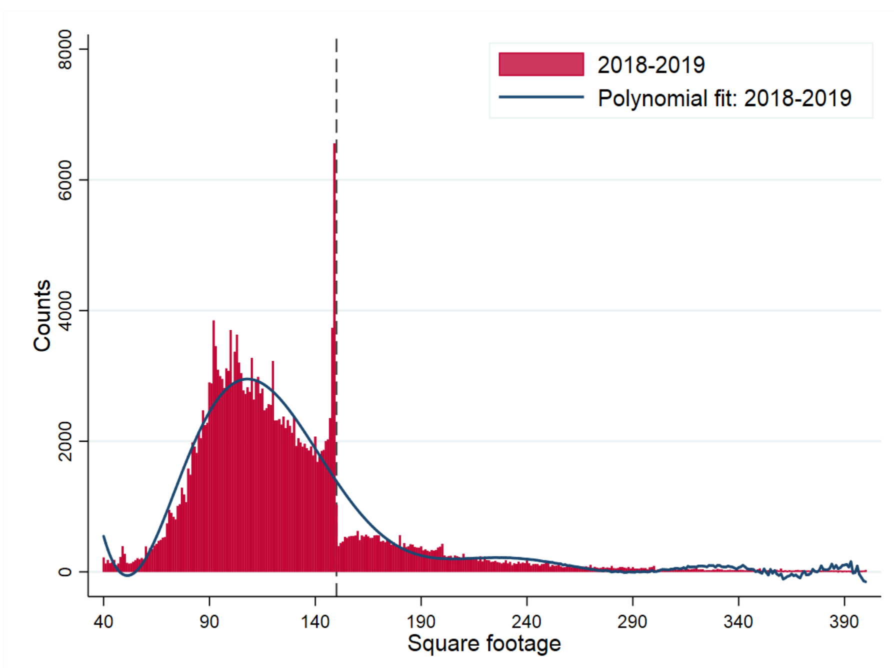
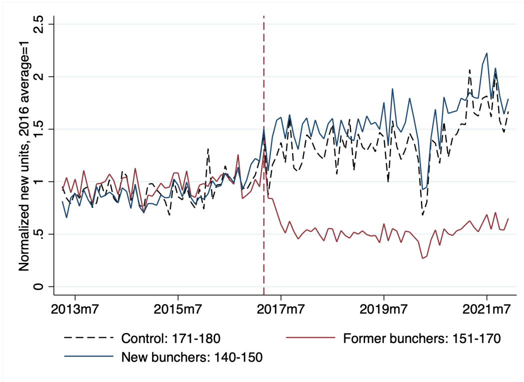
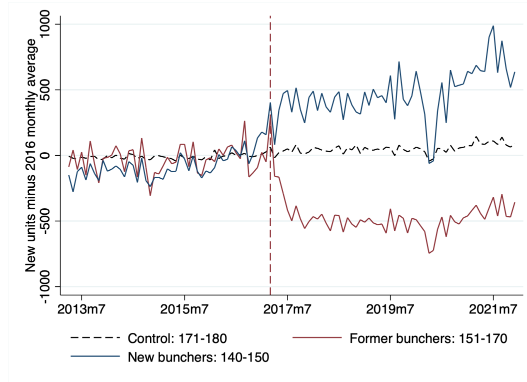


Figure C.8: **Distribution of the size of newly built units, after the 2017 reform** The figure plots the distribution of the square footage (*SDP*) of new units with approved building licenses from 2018 to 2019 in the Sit@del data. The histogram corresponds to the counts of units in each square meter bin, while the solid line plots a polynomial fit of order 10 excluding the manipulation range, according to the methodology defined in section 3.



(a) Relative changes



(b) Absolute changes

Figure C.9: **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.

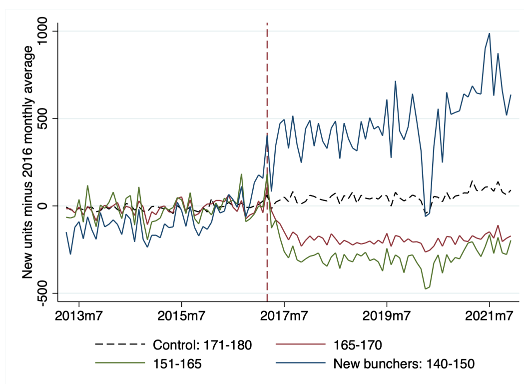


Figure C.10: **Impact of the 2017 reform on the size distribution for new units** The figure plots the impact of the 2017 lowering of the *ART* from 170 square meters to 150 square meters for the absolute number of new units built in four size categories: former likely non-bunchers in new bunching region (150-164), former likely bunchers (165-170), new bunchers (140-150), and control (171-180), in the Sit@del data.

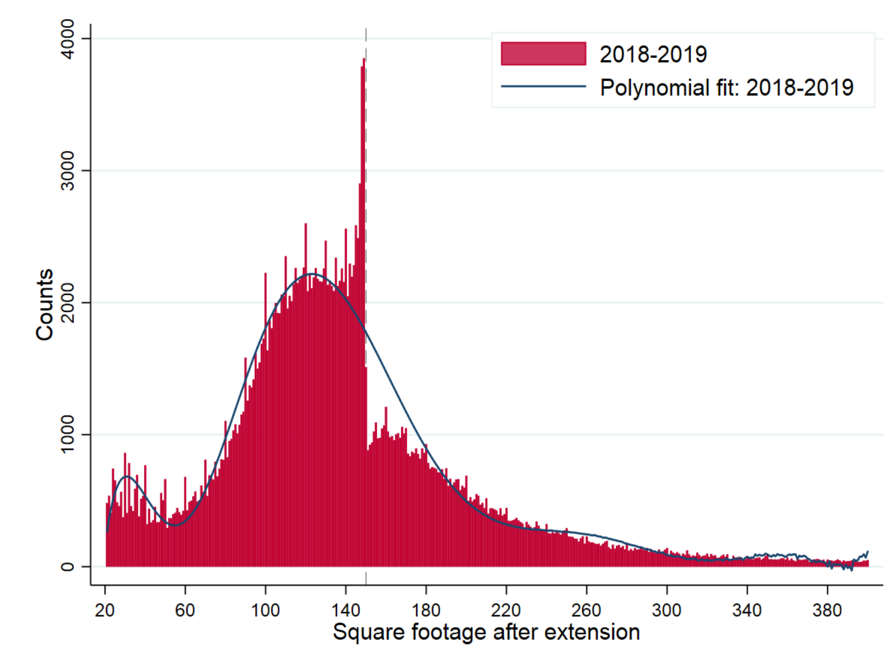


Figure C.11: **Distribution of the size of completed units for extensions, 2018-2019** The figure plots the distribution of the square footage (*SDP*) of completed units after extension projects, from 2018 to 2019 in the Sit@del data. The histogram corresponds to the counts of units for which the size 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 C.12: **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.

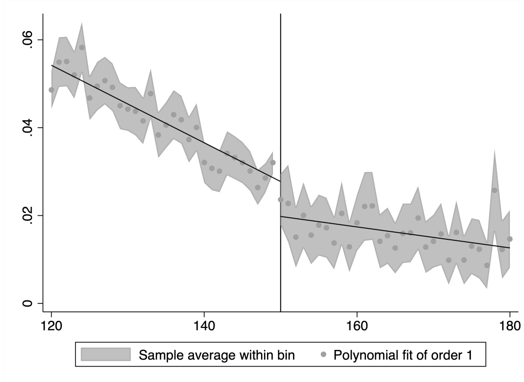
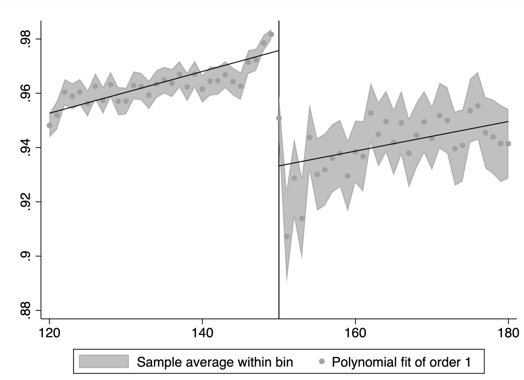
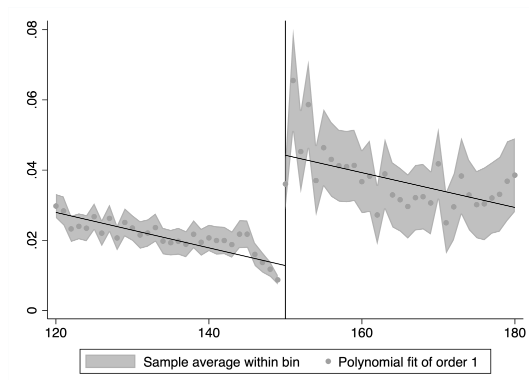


Figure C.13: **Share with means-tested zero-interest loans** The figure plots the share of households who received a means-tested zero interest loan for their construction project, for each bin of square footage of new units, after the threshold was lowered to 150 square meters, in the Sitadel data.



(a) Filer is an individual



(b) Filer is a developer

Figure C.14: **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.

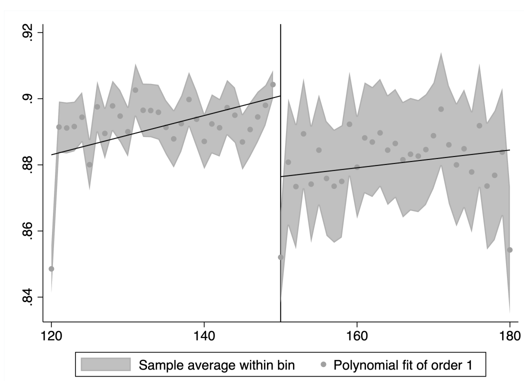


Figure C.15: **Primary home designation** The figure plots the share of units designed to be used as the household's primary home, for each bin of square footage of new units, after the threshold was lowered to 150 square meters, in the EPTB data.

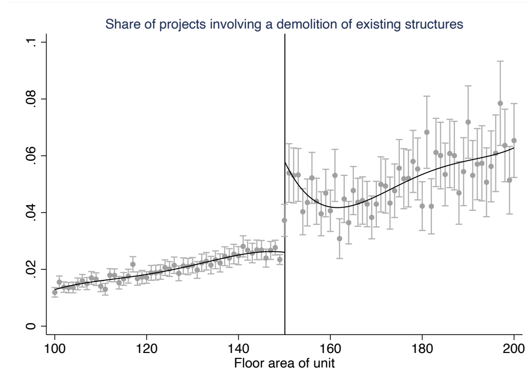


Figure C.16: **Share of projects involving a demolition** The figure plots the share of construction projects involving a demolition of existing structures, for each bin of square footage of new units, after the threshold was lowered to 150 square meters, in the Sitadel data.

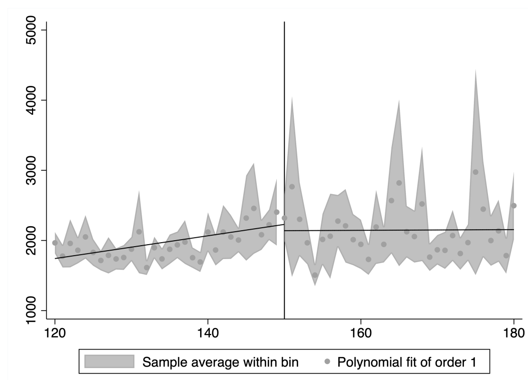


Figure C.17: **Average lot area** The figure plots the average land area of construction projects, for each bin of square footage of new units, after the threshold was lowered to 150 square meters, in the Sitadel data.

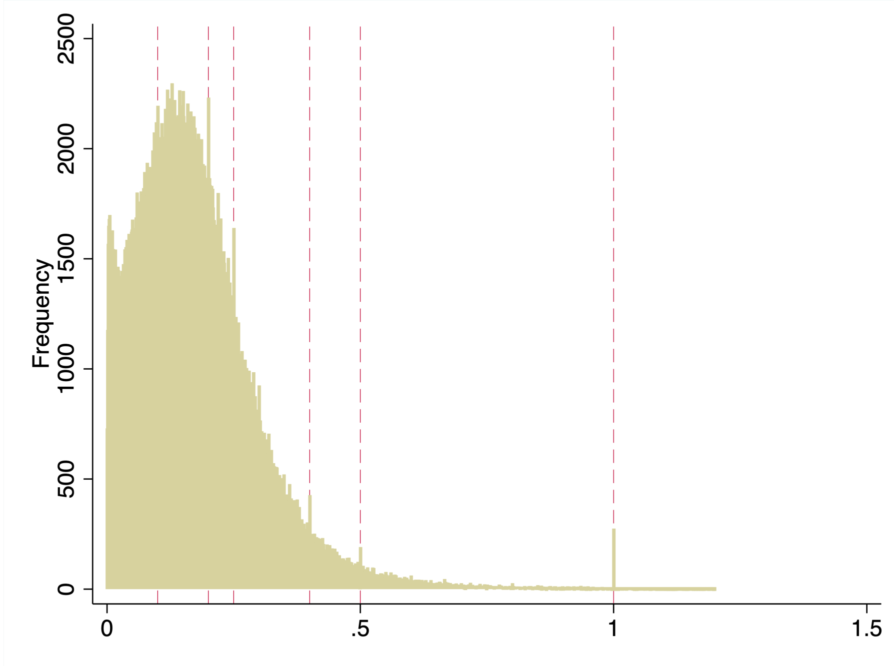
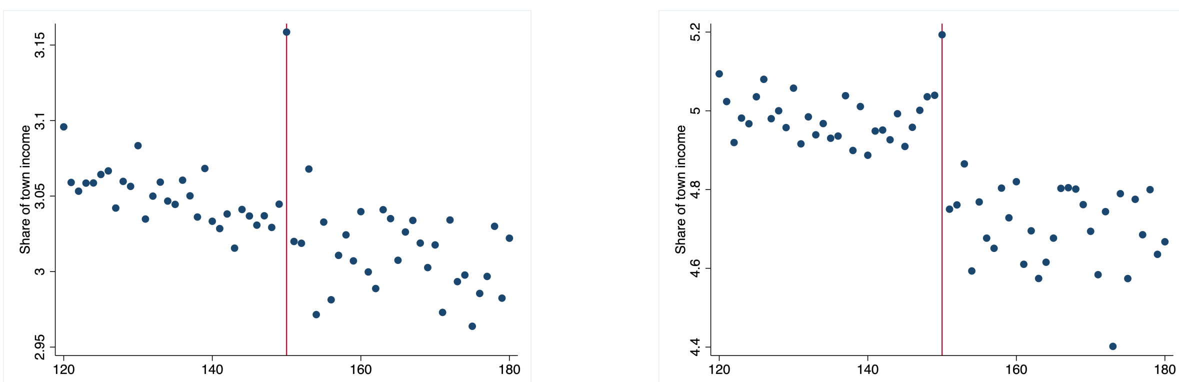


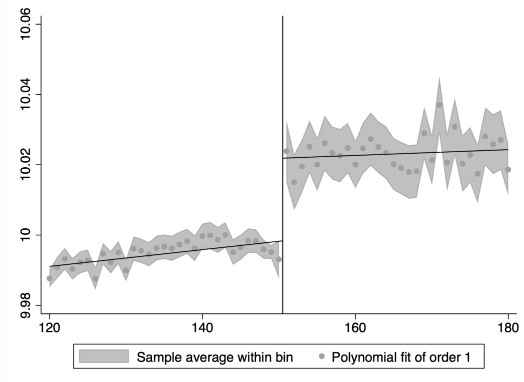
Figure C.18: **Distribution of the built-area ratio of new units, 2018-2019** The figure plots the distribution of the ratio of the square footage (*SDP*) to lot area for new units, from 2018 to 2019 in the Sit@del data. The histogram corresponds to the counts of units in each 0.001 width bin, while the vertical bars document common local binding built-area maximum ratios (0.1, 0.2, 0.25, 0.4, 0.5).



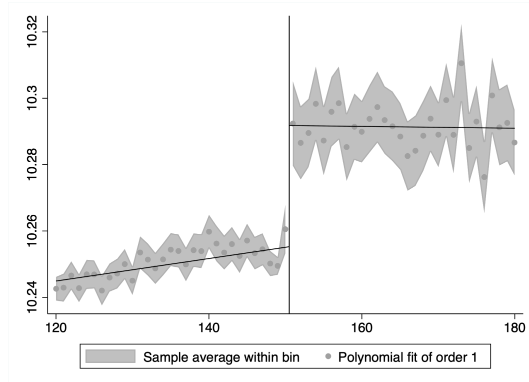
(a) Unemployment benefit share

(b) Other social benefits share

Figure C.19: **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.

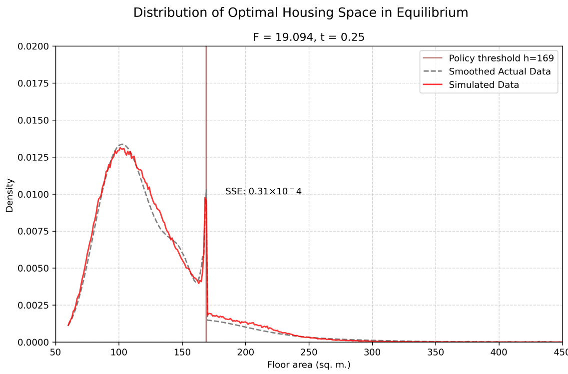


(a) Log Q2, income distribution

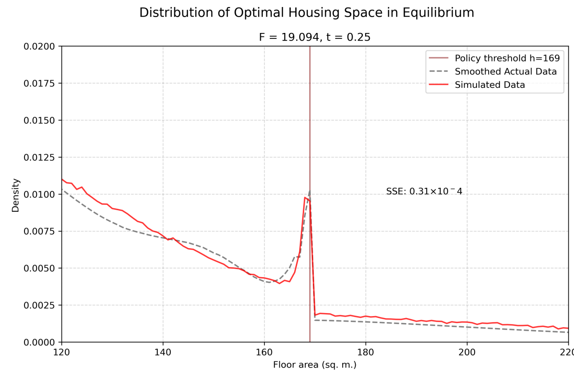


(b) Log Q3, income distribution

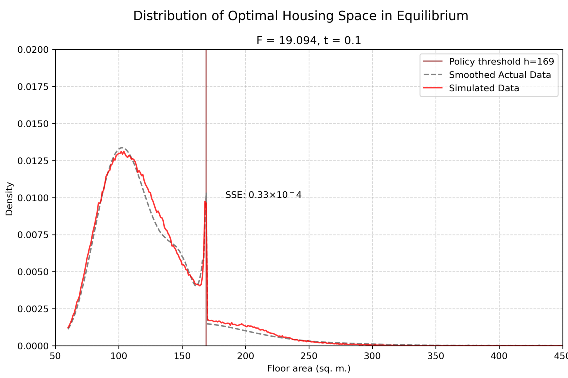
Figure C.20: **Town incomes, median and third quartile** The figure plots the average median and third quartile of the income distribution of the towns for each bin of square footage of new units, after the threshold was lowered to 150 square meters, in the Sitadel and *Filosofi* 2017 data.



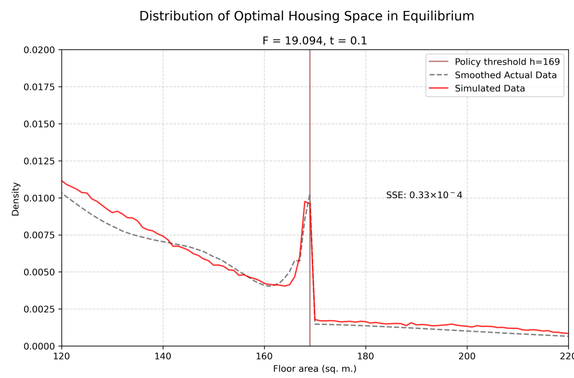
(a) t=0.25



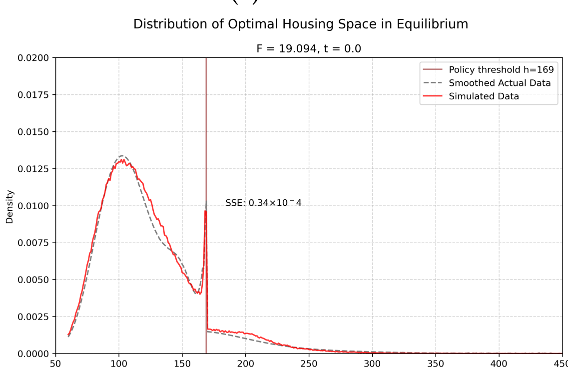
(b) t=0.25



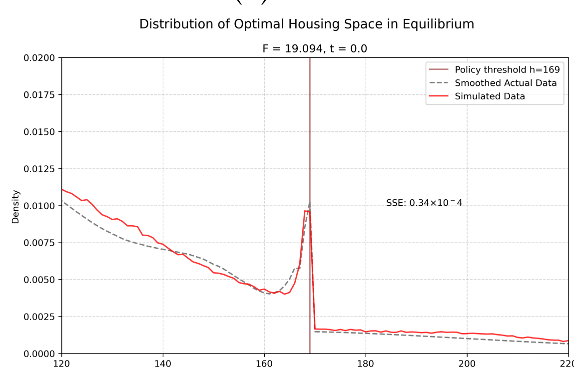
(c) t=0.10



(d) t=0.10

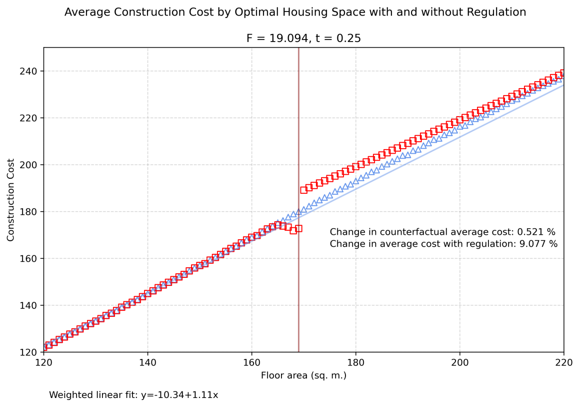


(e) t=0.0

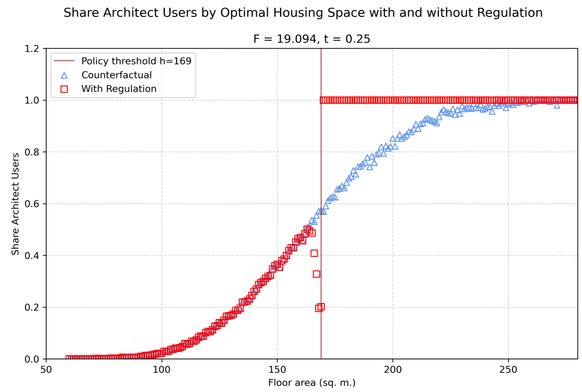


(f) t=0.0

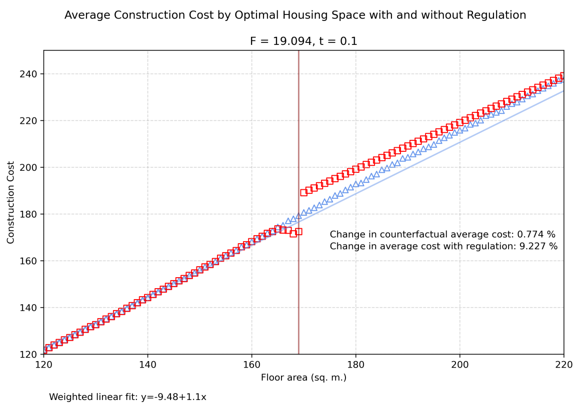
Figure C.21: **Model fit** Note: This figure plots the simulated distributions (colored lines) using structural parameters estimated via the method of simulated moments and the smoothed data distribution (grey dashed lines). The left panel shows the entire distribution of housing space, while the right panel focuses on the part of the distribution around the policy threshold. The set of estimated parameters used is $\widehat{\Theta}$ where $F = 19.094$. I simulate 30,000 households in a distribution and take the average of the simulated moments across 20 distributions. The weighting matrix used gives more weight to housing space bins near the policy threshold.



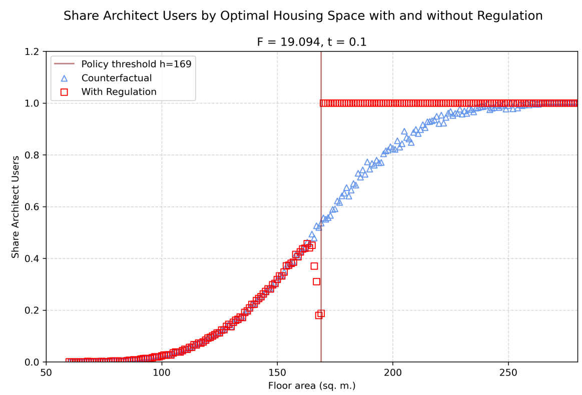
(a) Average construction cost, t=0.25



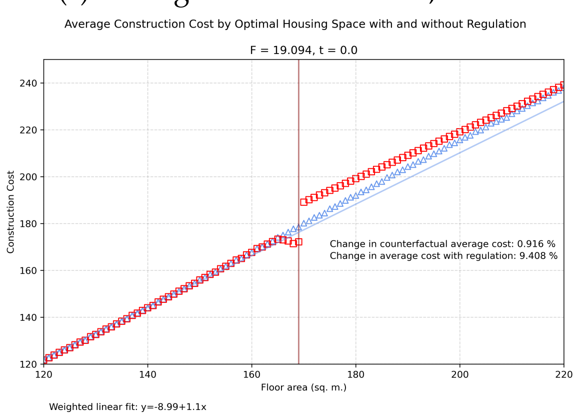
(b) Average share architect users, t=0.25



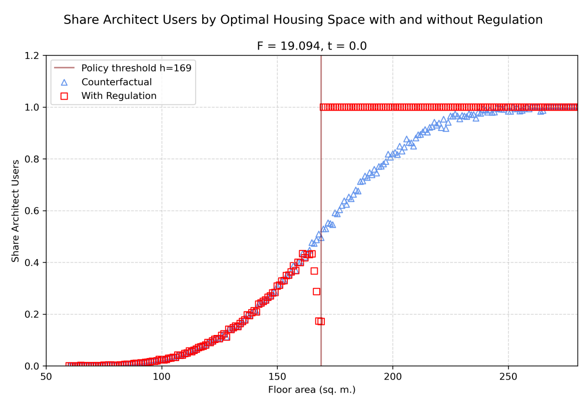
(c) Average construction cost, t=0.10



(d) Average share architect users, t=0.10



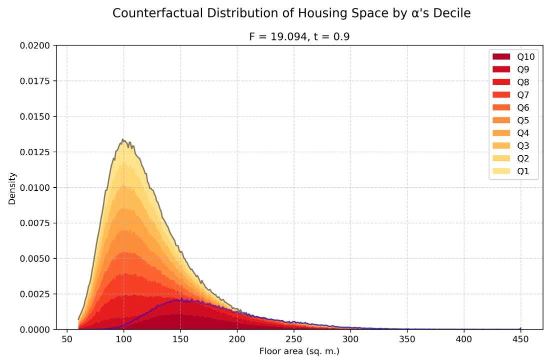
(e) Average construction cost, t=0.0



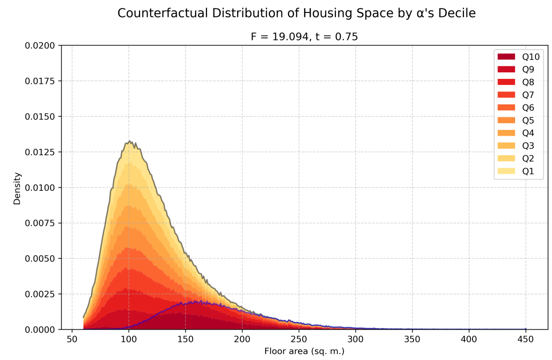
(f) Average share architect users, t=0.0

Figure C.22: **Model simulation** This figure plots simulated average costs and simulated share of architect users for each bin of housing space. The set of estimated parameters used is $\widehat{\Theta}$ where $F = 19.094$. I simulate 30,000 households in a distribution and take the average of the simulated moments across 20 distributions. The weighting matrix used gives more weight to housing space bins near the policy threshold.

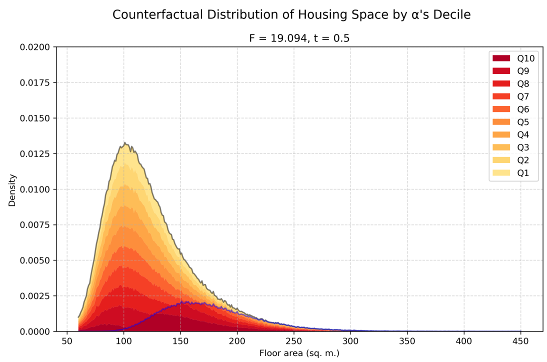
Figure C.23: Model simulation of counterfactual distributions of housing space by taste for quality α



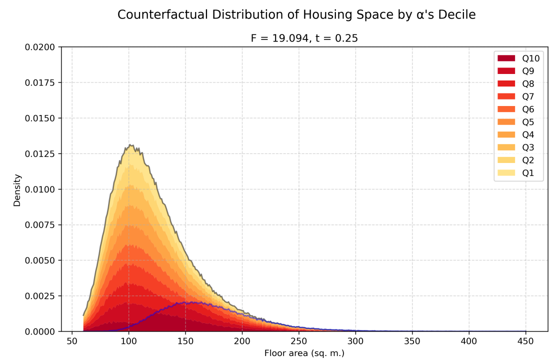
(a) t=0.90



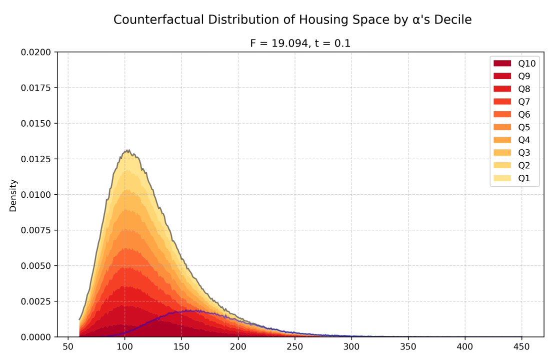
(b) t=0.75



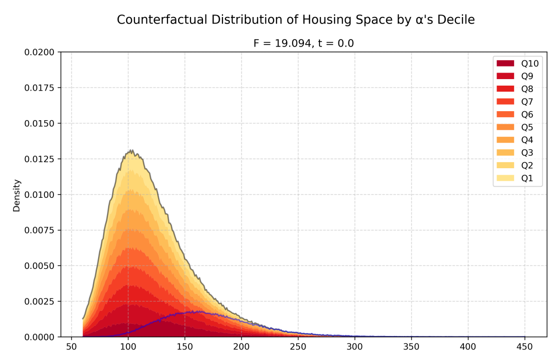
(c) t=0.50



(d) t=0.25



(e) t=0.10



(f) t=0.0

Note: This figure plots the simulated counterfactual distributions of housing space, stratified by the value of the taste for quality parameter α. The dark red color represents the highest decile of α while the light yellow color signifies the lowest decile. The blue line in the middle delineates architect users and non-architect users at every bin. The set of estimated parameters used is $\widehat{\Theta}$ where $F = 19.094$. I simulate 30,000 households in a distribution, keeping households with housing space ≥ 60 square meters. I then take the average of the simulated frequencies across 20 distributions. The weighting matrix used gives more weight to housing space bins near the policy threshold.