VERY LONG-RUN DISCOUNT RATES

ONLINE APPENDIX

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A.1 INSTITUTIONAL APPENDIX - UNITED KINGDOM

In this Appendix we expand on important institutional details of leasehold ownership in England and Wales. In Appendix A.1.A we provide historical background on the development of leasehold land law. In Appendix A.1.B we discuss requirements for leasehold registration with the Land Registry and the Land Registration Act 2002. In Appendix A.1.C we describe the U.K. property tax regime, and in Appendix A.1.D we outline restrictions on leaseholders' ability to make changes to the property. In Appendix A.1.E we describe the process of lease extensions, in Appendix A.1.F the role of ground rents and service charges, and in Appendix A.1.G the impact of leasehold covenants.

A.1.A Historical Background

The history of leasehold property ownership in England has its roots in feudalism, a system of land use and ownership that was common in Europe between the tenth and thirteenth centuries, and introduced in England following the Norman Conquest. Land was owned and controlled by a military or political sovereign ruler, who gave parts of that land to a number of lords as "tenants-in-chief," or "tenants-in-capite." The lord, in turn, could allow another person, a vassal, to use smaller portions of the land for a fixed period of time in return for pledging allegiance and military service to the lord. See Burn, Cartwright and Cheshire (2011) for a detailed review of the history of real property law.

There is no consensus as to the origins of the common lease length terms of 99, 125 and 999 years. McMichael (1921) describes the historical debate: *Matthew Bacon, author of "A Treatise on Leases and Terms for Years" published in London, England, in 1798, explains in various parts of his book that the ninety-nine year period represents three lives, but Bacon does not indicate why such a term was selected as the length of time a lease was to prevail. It is supposed by some that there was an English common law which prevented a lessor from granting a lease for 100 years and that it was therefore made for a somewhat briefer period, but no real evidence has ever been found to substantiate this theory.* 1,000 year leases were also common initially, with Jack Cade in Shakespeare's *Henry IV, Part II* exclaiming that "Now I am so hungry, that if I might have a lease of my life for a thousand years, I could stay no longer." McMichael (1921) also discusses theories of moving from 1,000 year to 999 year leases: *Lord Coke, who lived in the reign of Queen Elizabeth, in his writings on the subject of leases suggested that a lease for 1,000 years might on its face suggest fraud and it is thought that to avoid such a contingency the*

lessors of those early days set upon 999 years as the extreme limit for the life of a lease. Such leases, in any event, were made at that time.

A.1.B Leasehold Registration

For many decades, the registration of leasehold and freehold interests in the U.K. was governed by the Land Registration Act 1925. It was replaced in October 2003, when the new Land Registration Act 2002 came into effect. The two Acts regulate the registration procedures of ownership in real estate, both for freeholds and for leaseholds. In both cases, the law identifies cases in which registration of freehold and leasehold contracts is voluntary or mandatory, and outlines the procedure to register an interest. The main objective of the Land Registration Act 2002 was to further encourage voluntary registration of contracts, and extended the cases of mandatory registration.

In particular, under the current law, registration of a contract is mandatory when a leasehold of 7 years or longer is granted or transferred, or a freehold is transferred. When no transfer occurs, registration is not mandatory, though encouraged by the law. This could, for example, be the case for lease extensions. Finally, the law establishes that failure to register an interest will make the interest lose the so-called "overriding status": the owner of the interest may be vulnerable to successive transfer of the title that is registered.[1]

A.1.C Tax Treatment of Leaseholds and Freeholds

Her Majesty Revenue and Customs (HMRC), the tax authority for England and Wales, gives equal treatment to the price paid for leaseholds of different maturities or for freeholds when levying Stamp Duty Land Tax (SDLT), a tax on residential property transactions. Transactions below £125,000 are exempt from stamp duty, with rates rising progressively thereafter, to 5% for houses above £1 million and 7% for houses above £2 million.[2] The tax rate bands do not reflect marginal but total tax rates - a move into a higher tax band means that the higher rate is applied to the entire purchase. This would increase the value of the (cheaper) leasehold relative to freeholds, since they might end up in a lower tax band. Stamp Duty is also levied on the premium payable under lease extensions.

A.1.D Structural Changes to the Property

Since leasehold contracts can span several hundred years, it is important to understand the provisions that regulate the ability of leaseholders to make improvements to the property. Leaseholders are generally allowed to make minor (non-structural) improvements, unless explicitly restricted by covenants. For example, the leaseholder can renovate the kitchen or change non-structural walls. In addition, improvements to the property that are made by the leaseholder fully accrue to the leaseholder himself, since their value is excluded by law when computing the cost of a lease extension, i.e. the value of the extension is calculated as if the improvement was never made.

[1] See http://www.landregistry.gov.uk/professional/guides Practice guides 15 and 25.
[2] See complete current tax schedule at: https://www.gov.uk/stamp-duty-land-tax-rates.

Therefore, a leaseholder has the same incentives to improve the property as he would have had if he were a freeholder.

Structural changes to the property (like demolishing and redeveloping the building) are instead generally prohibited to the leaseholder without the consent of the freeholder. This restriction is unlikely to significantly affect our estimated discounts. First, a covenant against the making of improvements without consent is subject to the provision that consent shall not be unreasonably withheld (see Section 19(2) of the Landlord and Tenant Act 1927, and Appendix A.1.G below). Second, all leaseholds regardless of maturity are affected by this restriction. If anything, long leaseholds are more exposed to restrictions on redevelopments, since major redevelopments of the buildings are more likely to be attractive over longer horizons of time. Third, the need for the approval by the freeholder has only a marginal effect when redeveloping a multi-unit building, since owners of individual flats who would like to redevelop the property need the consent of all (or a vast majority of) other owners, regardless of whether they are leaseholders of freeholders. The need for the consent of the freeholder imposes only a small additional burden.

A.1.E Valuations, Leasehold Extensions, Tribunal Decisions

In this Appendix, we discuss the process of lease extensions in the U.K., focusing on the impact of lease extensions on interpreting our results. We first describe the legal rights of leaseholders to extend their lease. We then describe the role of Leasehold Valuation Tribunals (LVTs), which leaseholders can appeal to if they cannot reach an agreement with their freeholder on the premium payable for a lease extension; we discuss evidence that LVT decisions are favorable to leaseholders relative to the price discounts estimated in this paper. We next discuss the role of valuers in the lease extension process, and conclude by analyzing the net incentives to extend a lease, which trade off the possibly relatively cheap premia payable for extensions with the costs of doing an extension.

A.1.E.1 The Legal Right and Process to Extend the Lease

Over time, a number of laws have regulated the rights of leaseholders to extend a lease or purchase the freehold. The Leasehold Reform Act 1967 gave tenants of houses (not flats) with long leases the right to acquire either the freehold (a process called "enfranchisement") or an extended lease term. The Leasehold Reform, Housing and Urban Development Act 1993 conferred rights to collective enfranchisement and lease extensions by 90 years on groups of flat owners in the same building. The Commonhold and Leasehold Reform Act 2002 extended the right to lease extensions to individuals who have owned flats for at least two years.

The Acts also codify the bargaining process for a lease extension in the following way. First, the leaseholder files a proposal for extension, with an offered premium for the extra years to be acquired on the lease. The freeholder agrees, or proposes a counteroffer, and the two parties then bargain on the final price of the extension. It is common for both parties to solicit both legal

representation and the advice of professional valuers. This process can be expensive and time consuming, with the administrative costs of extensions often exceeding £4,000-£5,000 and the proceedings taking over two years to complete.[3] The total cost is composed of some fixed costs, for example, administrative fees, and some variable costs such as stamp duty taxes, that increase with the premium negotiated. In addition to a fixed payment, the leaseholders' valuers generally earn a fraction of the bargaining gain, the difference between the final premium and the freeholder's initial offer. The leaseholder is liable not only for his own costs but also for the legal, administrative, and valuation costs of the freeholder. In fact, the Acts established that the freeholder is to be compensated for "reasonable" costs incurred in connection with the lease extension; these costs are *in addition* to the premium payable for granting extra years on the lease.

A.1.E.2 The Treatment of Improvements

Where the leaseholder has made improvements to the flat which could affect its value (see Appendix A.1.D), these must be disregarded for the purposes of the valuation and determination of the premium. If the improvements are substantial the valuer will have to calculate the additional value they give to the flat (not what they cost) and then discount this from the estimated value of the flat; in effect the valuer has to assess the unimproved value of the flat. This treatment of improvements in lease extensions ensures that leaseholders have sufficient incentives to adequately maintain and invest in the property.

A.1.E.3 Tribunal Decisions

If the two parties cannot agree on a premium, the leaseholder can refer the matter to the Leasehold Valuation Tribunal (LVT) or, since July 2013, to the newly created First-Tier Tribunal (Property Chamber). Such Tribunals are part of Her Majesty's Courts and Tribunals Service. Each Tribunal usually consists of three members: a lawyer, who is often the chairman, a valuer and a lay person. There were five regionally based LVT offices (London, Northern, Midland, Eastern and Southern). There is no administrative fee payable to the U.K. government for LVT applications to determine the terms or price for enfranchisements or lease extensions. However, arguing before the LVT is generally a very last resort for leaseholders because of the significant costs related to legal advice and representation, valuers' fees, and the uncertain and lengthy process involved in court decisions. Individual costs may vary, but are generally estimated to run in the "tens of thousands" of pounds.[4] Any order made by the LVT can be enforced in the same way as a county court order. An additional layer of protection is granted via the appeal process: LVT or First-Tier Tribunal decisions can be appealed by either the freeholder or the leaseholder. The appeal is then judged by

[3]For an estimate of administrative costs of lease extensions, see http://www.telegraph.co.uk/finance/personalfinance/9060279/Home-owners-urged-to-extend-leaseholds.html.

[4]For an example of cost estimates, see the Westminster City Council publication: https://www.westminster.gov.uk/sites/default/files/uploads/workspace/assets/publications/Homing-in-on-the-issues-Perspec-1375182291.pdf.

the Upper Tribunal (Lands Chamber).[5] The fee for lodging an appeal is £250. Further legal and valuation advice costs are incurred for the appeal, and the court judgment can allow freeholders to recover these costs via increases in their service charges to leaseholders. A final layer of protection is to appeal the Upper Tribunal decision to the House of Lords, but this appeal can only be concerned with a general point of law and not with the specific valuations of a particular case.

The legislation provides a number of restrictions on how the properties and lease contracts are to be evaluated by the Tribunal in assessing the payable premium in case of a lease extension or the enfranchisement cost in case of outright purchase of the freehold. The Tribunal is instructed to consider the amount that the property "might be expected to realize if sold on the open market by a willing seller to a willing buyer" (Leasehold Reform Act 1967), a reference to market values, but also to disregard a number of features that would actually affect market values. For example, the valuation is not supposed to include improvements made by the leaseholders and ignore the possible value of the option to extend the lease under the current (shorter) lease.

In determining the valuations, the Tribunal relies both on the input of the leaseholder and the freeholder, but is actually not required to rule within that range.[6] Both the leaseholder and the freeholder submit a proposal for the premium payable as well as a rationale for the premium calculation, generally based on a valuer's report. These rationales mainly take two forms: a "comparables" analysis that considers transactions of similar properties, and a model-based derivation of the premium.

The comparables analysis offered by the parties is generally based on very few properties, often one or two apartments; we discuss the potential shortcomings of the hedonic adjustments by valuers below. The second source of input is model based, often relying on a simple Gordon growth valuation. The inputs on the model are not chosen for their realism, nor because they reflect anyone's actual market valuations, but simply as a way within the assumed model to recover the desired premium. As the Tribunal reports in [LRA 55 2002]: *It would in our view prevent any significant weight being placed upon such an analysis unless there was clear evidence that the adjustments made by Ms Tolgyesi were soundly based and were not so coarsely grained as to obscure and influence (if not indeed provide) the answer which is sought to be found rather than reliably to reveal that answer.*

Since exponential discounting is very sensitive, particularly at long horizons, to the net discount rate, Tribunal decisions have focused on determining a model-based $r - g$. The most cited decision on this matter is commonly known as the "Sportelli Appeals." The Tribunal decided for a net discount rate of 5%. The estimate was reached by cumulating estimates of: 2.5% for the risk-free rate (based on inflation linked bonds), a real growth rate of GDP of 2% (based on long-term

[5] Permission to appeal must first be requested from the First-Tier Tribunal, if this Tribunal does not grant permission to appeal, the permission can then be sought directly from the Upper Tribunal (Lands Chamber). See http://www.justice.gov.uk/tribunals/lands for more information.

[6] The Tribunals are not required to rule within the range of disagreement between the freeholder and the leaseholder, but can rule on the entire case including the validity of the lease. While in practice rulings do not often stray away from the parties inputs, large deviations are possible. For example, in a £9,000 service charge dispute, a LVT decision forced the leaseholder to forfeit the flat (valued at £600,000) and to pay £70,000 in legal fees (see http://m.wandsworthguardian.co.uk/news/10244117.Photographer_forced_to_forfeit_home/).

growth in Britain), and a housing risk premium of 4.5% (based on the equity premium).[7] The 2.5% average long-term risk-free rate is considerably higher than the $1 - 1.4\%$ we documented using the U.K. government yield curve. The 2% rate of growth of the economy is considerably higher than the real growth rate of rents (the object of interest in the formula), observed in the data at 0.5%.[8] The risk premium is a subjective estimate extrapolated from the equity market, and had previously been estimated at 2.5% by the courts (see the "Arbib" decision). While the courts made reference to a form of CAPM, at least a constant discount rate one, in setting the discount rate, they made no reference to actual market valuations. In discussing the realism of a 5% rate, the barristers Tanfield Chambers remark that: *"A lot of surveyors, particularly provincial valuers, will tell you that the prices paid in the market simply do not reflect such rates"* and conclude that a lower rate is more consistent with market valuations.[9]

Consistent with this, in ongoing work, Badarinza and Ramadorai (2014) analyze about 400 Tribunal decisions to grant lease extensions. They find Tribunals to award extensions at premia more favorable to leaseholders than the market valuations estimated in this paper. While Tribunal valuations are subject to a number of arbitrary criteria such as leaseholders' and freeholders' guesswork of what the property might be worth in a market transaction that is not actually observed (also see Appendix A.1.E.4 below), such results alleviate the concern that our estimated discounts are purely due to a hold-up problem. In fact, if Tribunals on average are more favorable to leaseholders, this should provide leaseholders with a more credible remedy in the bilateral negotiations with freeholders.

A.1.E.4 Leasehold Extensions and Valuers' Opinions

Valuers offer advice to freeholders and leaseholders on the premia payable in lease extensions or enfranchisements. They mainly base their valuations on personal experience in past extensions and on past Tribunal decisions. Their role is comparable to the guidance offered to clients by real estate agents in the process of buying or selling a property.

When consulting for parties during the process of lease extension, valuers are only interested in establishing the payable premium, because it is the only amount being transacted in an extension (or an enfranchisement). While the premium might be determined by also considering the percentage of the freehold value it represents, such percentage values, which are the focus of this paper, are only secondary objects of interest in extension transactions. Nonetheless, in this section of the Appendix we review a number of relative valuation curves (often called "relativity curves") produced by a variety of valuers. We focus on the summary provided by the Royal Institute of

[7] See point 31 and 35 in the report "Sportelli: The Aftermath" by Tanfield Chambers: http://www.tanfieldchambers.co.uk/Asp/uploadedFiles/File/seminar%20notes/SportelliFEB.2009.pdf.

[8] Furthermore, using the growth rate of GDP or consumption of 2% for the growth rate of rents is inconsistent with the idea that total rents are a constant fraction of consumption in the long run despite the fact that people live in better and bigger houses over time. A positive quality-quantity adjustment implies that rents for a specific property must grow less than per-capita rents.

[9] These differences between the prices for extension established by Tribunals and market price differences between freeholds and leaseholds makes it hard to infer true household preferences from data on Tribunal decisions.

Chartered Surveyors (2009). Generally, these valuers tend to use higher discount rates than the ones we have shown to be necessary to match the data. For example, the valuations suggested by Savills are approximately consistent with a net-of-growth discount rate of 3.5%, while we have shown a rate of 1.9% to be necessary to match our price data.

While valuers' views are a potentially interesting source of information, they are not based on any systematic analysis of market data; indeed, prior to our analysis, there has been no systematic, large-scale analysis of the relative valuation of leaseholds and freeholds. Instead, as reported in the summary of 14 different relativity curves in Royal Institute of Chartered Surveyors (2009), the main inputs in the construction of those curves are: (i) "opinions," which are a key input in 6 out of 14 cases; and (ii) Tribunal decisions or past extensions (in all but 3 cases). Only 4 of the curves had any reference to actual market transactions, half of which only used transactions from before the 1990s.[10]

The almost exclusive reliance of valuers' analysis on past Tribunal decisions and extensions, or alternatively personal opinions, makes it difficult to infer the true relative valuation of freeholds and leaseholds as determined by household preferences from relativity curves. This is true for two reasons:

First, as discussed above, extensions and Tribunal decisions do not necessarily reflect market values, due to distortions imposed by the various regulations mentioned above. As the Tribunal itself reports [LRA 39 2011]: *It is a false hypothesis to assume that settlements do not suffer from a number of potential distortions: there are poorly represented tenants, there are tenants who may be subject to pressures unrelated to the market place, and many settlements amount to "second guessing" what will happen at a tribunal.* The Tribunal is also aware of the limited information contained in the valuers' relativity curves [LRA 39 2011]: *We have been acutely aware of the difficulty of reaching a satisfactory conclusion on relativity in the light of the inadequacy of the available evidence, and it is clear that this is a problem that is likely to confront LVTs in all such cases. The likelihood is that decisions will be varied and inconsistent.* Similarly, the Appeals Tribunal mentions that *the "graph of graphs" – described by the LVT as "an average of averages" [of relativity curves] - are based upon limited, undefined data from all areas outside central London*. To summarize, with the words of the Tribunal [LRA 49 2008]: *In our judgment leasehold valuation tribunal decisions on relativity are not inadmissible, but the mere percentage figure adopted in a particular case is of no evidential value.*

Second, even when the "personal opinions" of valuers are based on the observation of actual transactions, the difficulty of performing the necessary hedonic analysis with small samples of very heterogeneous properties leaves large scope for influencing the outcome by arbitrarily choosing the value of the hedonic components, as shown in many documents related to the Tribunal decisions. Consider for example the following extract from [LRA 69 2006], in which the Tribunal describes the hedonic adjustment of a particular valuer: *Ms Joyce made the following ad-*

[10]For example, Savills's analysis is based on open market valuations for 240 leasehold properties with varying lease lengths in central London. For each of the properties, valuations were carried out by agents and valuers from thirteen agency and surveying practices. Each person was asked to provide valuations for a sample of 10 properties under a standard set of assumptions. See Royal Institute of Chartered Surveyors (2009) for more details.

justments to the prices paid in each case. For time, she used the Savills PCL South West Flats Index. [...] She deducted 12.5% to reflect the fact that flat 4, 3 Lennox Gardens, [...] had all been modernised and 7.5% to reflect the partial modernisation of flat D, 41 Lennox Gardens, the first floor flat at 31 Lennox Gardens and flat 8, 75-77 Cadogan Gardens. She did not make an adjustment in respect of flat 3, 27 Lennox Gardens, because she offset the value attributable to improvements against the large amount outstanding on the service charge. She considered that generally a second floor flat was worth 15% less than a first floor flat. She therefore added 17.65% to the prices paid for second floor flats in order to express them in terms of first floor values. She deducted 7.5% from the price paid for flat 3, 37 Cadogan Square to reflect its location on the more popular east side of the square and added 5% and 10% respectively to prices paid in Cadogan Gardens and Lennox Gardens to reflect the superior location of Cadogan Square. As a second example, the main discussion in the case [LRA 108 2008] revolved around the valuation of the *only* comparable property: a property relatively similar but with an additional "very small garden". Such garden was assigned different values by different valuers, in the range of £15,000 to £30,000; note that the total cost of the extension in that case was £18,000, not very different from the range of alternative values assigned to the garden. As a last example, consider the valuation of valuer Ms Tolgyesi as described by the Tribunal [LRA 55 2002]: *It will immediately be apparent that the making of adjustments to each comparable transaction can have a critical and indeed determinative effect upon the answer. Thus the adjustments made by Ms Tolgyesi are made in 5% increments – in some cases no adjustment is made but in others a 5% adjustment in others a 10% adjustment and in some a 15% adjustment is made. It will be seen that the size of the adjustments is greater than the difference (i.e a difference between 95% and 99%) which Ms Tolgyesi is seeking to measure.*

When discussing our findings with market participants, we found their priors on the relative valuation of leaseholds and freeholds to be very dispersed. While some valuers have argued for lower leasehold discounts than those we estimate (see above), a number of other market participants instead reported increases in the value of the lease with maturity that are much higher than those estimated by the valuers. Consistent with this, when asked to value the difference between a 138-year leasehold and a freehold [LRA 55 2002], *during cross-examination [a valuer] was asked to consider a hypothetical situation involving two identical properties – one freehold and one held on a long lease with 138 years unexpired. If acting for a purchaser of the long leasehold property, at a purchase price of £950,000, he accepted that a purchaser would be willing to pay a further £40,000 for the freehold property – although he commented that the long leasehold property would also sell for around £990,000 owing to the general demand for property*. While the Tribunal notes the obvious inconsistence in the valuer's statement that the long leasehold would at the same time be worth £990,000 and £950,000, the provided answer is further indication of the willingness of buyers to pay a substantial amount to increase the lease maturity from 138 years to infinity (particularly since, in this case, the valuer represented the leaseholder and, consequently, had an incentive to state a price difference as small as possible). In addition, websites that counsel on lease extensions often mention that the *cost* of lease extension is well below the actual increase in market value of the property. For example, the website lettingfocus.com reports: *The cost of extending leases got a bit more expensive in the last few*

years...But it can still make good sense [to extend] and of course will increase the value of your flat, usually by a lot more than the cost to extend the lease.[11]

To conclude, we believe that prices paid for past extensions and valuers' opinions provide a potentially interesting source of information about the leasehold market. However, due to various distortions, extensions do not generally happen at market prices. At the same time, valuers' opinions are based for the most part on past extensions and Tribunal decisions, and are, at best, based on subjective hedonic analysis with little or no transaction data. In contrast, we provide an extensive formal hedonic analysis using the entire universe of transactions in England and Wales and an extensive set of hedonic characteristics and fixed effects.

A.1.E.5 Net Incentives to Extend

As highlighted in Section IV.H, one possible concern with interpreting our results is the asymmetry in power between freeholders and leaseholders when it comes to negotiating lease extensions. The asymmetry occurs because freeholders, most often large estates or companies, generally hold a large number of properties, while leaseholders are typically individual homeowners. The laws described above were, in fact, primarily motivated as a way to mitigate the hold-up problem, granting the right to a lease extension as well as Tribunal protection if such extension cannot be achieved in bilateral negotiations with the freeholder.

The evidence on the Tribunal's decisions suggests that the laws have indeed managed to contain the average price that leaseholders pay for extensions through the Tribunal process, which in turn should mitigate the hold-up problem ex-ante. Of course, the threat of referring the matter to the Tribunal to take advantage of seemingly low premia has to be balanced with the substantial costs of such an option. A hypothetical new home buyer that wanted to take advantage of the legislation would have to buy the property, wait for two years, and then hire a valuer and a solicitor to file for a lease extension; if a favorable extension cannot be agreed with the freeholder, the leaseholder has to file a complaint with the Tribunal, and, even after the Tribunal ruling, face the risk of an appeal to the Upper Tribunal (and in some cases to the House of Lords after that) from the freeholder. The potential length of this process runs into several years and the cost associated quickly rise to tens of thousands of pounds. However, while these prospects are likely to be daunting for most leaseholders, they do put significant bounds to the ability of the freeholder to hold up the leaseholders.

A final consideration concerns the possibility that the favorable treatment of Tribunals towards leaseholders may even over-compensate them for the hold-up problem, in fact increasing the ex-ante value of a leasehold by lowering the cost of extensions (directly in court, or indirectly outside of courts). If this was the case, it would produce a bias against our results of large leasehold discounts, because it would imply that leasehold buyers would bid up prices for short leaseholds in the hope of obtaining cheaper extensions in court (or possibly even out of court). We find the strict arbitrage logic between market prices and Tribunal decisions required for sig-

[11] See: http://www.lettingfocus.com/pages/myarticles_leaseextensions.html.

nificant quantitative effects to run contrary to the substantial costs and waiting times (with the ensuing illiquidity) of the Tribunal process, the indivisibility of the housing asset, and the plausible segmentation of the market (see Shleifer and Vishny (1997); Piazzesi, Schneider and Stroebel (2013)).

Large freeholders have historically proved combative, even in the Tribunal system, and could be willing to sustain high legal costs on an individual case because of the repeated game nature of extensions on their total portfolio. This increases the risks associated with extensions. For example, the Earl of Cadogan, one of the largest freeholders in prime central London, brought cases against individual leaseholders through the three stages of court: LVT, Court of Appeal, all the way to the House of Lords. While the expenses connected with these legal battles make each of the cases unprofitable, there are large ripple effects on the rest of the freehold portfolio. Damian Greenish, the senior partner of Pemberton Greenish who acted for the Earl Cadogan in the House of Lords appeal "Earl Cadogan and others v Sportelli and others [2008 UKHL 71]," said that the favorable ruling could save big property owners like the Cadogan Estates millions of pounds and added: *We're over the moon about it. Had this gone against us it would have allowed the manipulation of claims to the detriment of landlords*.

Furthermore, the legal framework we discussed in this section shows that only a limited amount of information regarding preferences or expectations can be inferred from the Land Valuation Tribunal's decisions. First, as the legal arguments happen in the narrow context of precedent (with the U.K. being a common law country), there is often little scope for parties to reveal their true valuations of properties, extensions, and discount rates: rather, all the valuations provided to the court are inputs in a predetermined framework established by the jurisprudence. Second, the fact that only a very selected sample of leaseholders and freeholders bring the bargaining about extensions to court is consistent with the valuations and costs incurred by those who ultimately debate the extension in court not being representative of the valuation or costs of the average leaseholder or freeholder. For example, the fact that the leaseholder and the freeholder that we see in court sometimes dispute only small amounts of money may indicate that those parties went into trial with the expectation that the tribunal would award them more than originally contended.[12]

In addition to the costs of a lease extension, the effect of potentially cheaper lease extensions on ex-ante leasehold values would also be reduced if leasehold buyers were not fully aware of the details of the extension process at the moment they buy the property. While the tenure of the property is widely publicized on the sales listings, the technical details of the lease extension process may not be always understood by buyers until the moment when they actually decide to extend. Indeed, repeated calls by public authorities and newspapers to extend the lease when there are more than 80 years remaining suggest low general awareness of important details of the

[12] Alternatively, they may be parties with particularly low costs of going to trial (low personal cost of time or litigation), as in the case of [LRA 108 2008], where the parties went all the way to the Appeals court out of a likely maximum potential gain of £7,000, certainly an amount below the expected cost of each step of the trial. This evidence certainly does not imply that the average leaseholder would have gone all the way to the Appeals court in a dispute over £7,000, given that as mentioned the cost of legal representation can run in the tens of thousands of pounds.

law regulating extensions.[13] In particular, the law induces a discontinuity in extension prices at 80 years remaining, which makes it significantly more expensive to extend once there are less than 80 years remaining. For leaseholds below 80 years remaining, the Tribunals determine a "marriage value," defined as the increase in value for the leasehold interest due to the longer length of the lease minus the decrease in value to the freehold interest for the same extension. The law requires that for leaseholds below 80 years, the marriage value is to be split equally between freeholder and leaseholder, while for leaseholds above 80 years, it accrues entirely to the leaseholder. This makes lease extensions below 80 years more expensive for leaseholders.[14] If buyers were fully aware of this rule, we would expect a large number of buyers to extend when more than 80 years remain on the contract, or at the very least to avoid extending just below 80 years. Instead, we find in our data that 84% of the extensions happen when the contract has less than 80 years remaining, with twice as many leaseholders extending with 75-79 years remaining as those extending with 80-84 years remaining (15% of the sample vs 7%). Since leaseholders who wait to extend until the remaining maturity falls below 80 years leave a substantial amount of money on the table, this suggests that they may not be fully aware of the costs and benefits of an extension or that other frictions are preventing them from taking advantage of the opportunity. Therefore, it would not be surprising to find other features of the lease extension process, like the relatively low average extension costs determined by the Tribunal, to have little ex-ante effect on the market prices of leaseholds.

Ultimately, the existence of a strong protection of leaseholders by Tribunals puts a strong bound on the potential hold-up of the leaseholder by the freeholder, and, if anything, may increase leasehold prices, biasing against us finding significant discounts. While a variety of model-based or small-sample "comparables" measures of leasehold discounts have been used in the industry, our analysis provides the first large scale systematic evidence. Finally, interesting puzzles on the optimal exercise of the extension option remain open for future research.

A.1.F Ground Rents and Service Charges

Ground rents and service charges might also affect the value of leaseholds relative to freeholds. Below we describe the relevant institutional details. Neither is important enough to significantly affect prices paid, as discussed in Section IV of the paper. Since ground rents and management fees are present for leaseholds of all maturities, the fact that 700+ year leaseholds trade at the same price as otherwise identical freeholds shows that they cannot contribute significantly to leasehold discounts relative to freeholds.

Ground Rents: Leaseholders sometimes have to pay annual ground rents to the freeholder, since the purchase price of the lease only covers the temporary ownership of the structure. The

[13] http://www.theguardian.com/money/2011/feb/26/lease-running-out-buying-freehold

[14] The existence of marriage value, a form of failure of Modigliani-Miller theorem, is another symptom of frictions and failure of arbitrage in this market, particularly for short term leases.

land still belongs to the freeholder who has the right to request that the lessee make regular payments for the use of the land.

Ground rents are set on a property by property basis and no centralized database exists. This makes it hard to control for them in a regression analysis. However, the amounts involved are usually very small (£10-£100 per year) and in many cases are either zero or a symbolic amount ("a peppercorn"). In the 2011-12 English Housing Survey, amongst those households reporting to pay ground rents, the median household reported annual rents of about £25. In addition, all leases extended under the Leasehold Reform, Housing and Urban Development Act 1993 are set at peppercorn levels. Even in cases where the ground rent is in principle positive, it is often zero in practice, because for the rent to be collected the freeholder has to make a specific written request to the leaseholder. Oftentimes such requests are not made because the amount collected would be too small to cover the administrative costs.

Service and Insurance Charges: Service charges are payments by the leaseholder for services provided by the landlord. These include maintenance and repairs, insurance of the building and, in some cases, provision of central heating, lifts, porterage, estate staff, lighting and the cleaning of common areas. In the 2011-12 English Housing Survey, 46% of leaseholders reported paying a service charge; amongst those households the median annual payment was about £750.

While maintenance costs can be non-trivial, as long as the maintenance is carried out at fair value (the private market cost of the works) service charges do not represent a problem for our analysis, since freeholders would also have to pay for the maintenance of the property. Having the landlord conduct maintenance may even be efficient, because she will likely enjoy significant economies of scale.

A potential problem exists if freeholders might attempt to extract monopoly rents via the service charge, as suggested by some newspaper articles such as The Observer (2013). We do not, however, believe that this is a likely explanation of the leasehold discounts estimated in the data. The ability to extract rents is severely limited. First of all, under the Commonhold and Leasehold Reform Act 2002 an application can may be made to a Leasehold Valuation Tribunal to challenge the reasonableness of service charges. Secondly, the Commonhold and Leasehold Reform Act 2002 provides a right for leaseholders of flats to force the transfer of the landlord's management functions to a special company set up by them - a "right to manage" company. This does not require the landlord's consent, and significantly limits her ability to extract unreasonable service charges.

Similarly, in some cases the lease requires that the leaseholder insures the property, usually a house, through an insurer nominated or approved by the landlord. The tenant may consider that he can get cheaper insurance from different companies and may be concerned as to the cover provided. The provisions of Section 164 of the Commonhold and Leasehold Reform Act 2002 provide a right for the leaseholder to arrange his own insurance, provided he notifies the landlord.

A.1.G Leasehold Covenants

A further concern might be that contractual covenants in leasehold deeds place restrictions on leaseholders that reduce the value of the leasehold relative to the freehold. We analyze a large number of covenants from deed titles individually downloaded from the Land Registry website to determine whether or not such contractual restrictions might explain the estimated discounts.[15] In this section, we present examples of the covenants discovered in these titles, after removing any personal identifiers. Many leaseholds do not carry restrictions; others contain only old, out-of-date restrictions, which, while technically still in place, are generally not enforced.[16] In Appendix Section A.1.G.1 we conduct a systematic analysis of all leasehold covenants in a particular part of London to show that they do not vary systematically by initial lease length.

When present, we find four main types of covenants. The first and most common type of covenant involves restrictions on the **broad type of land use**, such as restricting structures to be residential rather than commercial. Usually these are consistent with council zoning regulations, which would also apply to the owners of freeholds:

> No building now or hereafter to be erected on the premises hereby transferred or any part or parts thereof shall at any time hereafter be used for any other purpose than that of private dwellinghouses buildings and appurtenances belonging thereto and no block of flats hotel factory or retail shop or other premises for the sale of goods by retail shall be erected on the premises hereby transferred and that the Purchaser and its successors in title and assigns will not at any time use exercise or carry on or permit to be carried on upon any part or parts of the premises hereby transferred or any buildings for the time being erected or to erected or standing thereon any trade manufacture or business or do any act or thing which may be or grow to be in any way offensive noxious or dangerous to the Vendor or its Superior Lessors or tenants or the owner or tenants of adjoining property forming part of the Vendor's estate or any part thereof and will not use or permit to be used the premises hereby transferred or any buildings erected thereon or any part thereof for the purpose of manufacturing storing selling supplying or distributing either by wholesale or retail ales beers wines spirits or any other intoxicating liquors nor shall any house or building erected or to be erected on the premises hereby transferred or on any part thereof be converted or used for such purposes or used as a cinema or a club or clubs at which intoxicating liquors may be stored sold or supplied.

Note that while those covenants restrict the use of land and future structures to be residential, there are no further restrictions on the construction of such new residential properties. Some

[15] http://www.landregistry.gov.uk/public/property-ownership allows the download of individual deeds, including any covenants on the land, for a charge of £3 per title.

[16] For example, a leasehold for a flat states that "A Conveyance dated 20 June 1864 made between (1) [Person A] and (2) [Person B] contains restrictive covenants but neither the original deed nor a certified copy or examined abstract thereof was produced on first registration."

leasehold covenants do place restrictions on the **construction of a new structure**. To the extent that there are such restrictions on new structures, many times they again relate to restrictions placed by the council, and would equally apply to all new structures that freeholders might want to erect (see in particular point 3 of the following leasehold covenant):

> The land tinted pink on the filed plan is subject to the following stipulations contained in a Deed dated 10 August 1923 made between (1) [Person A], (2) [Person B] (3) [Person C].
>
> 1. No church chapel synagogue or other place of public worship or instruction manufacturing premises institution nursing home lunatic asylum sanatorium creche school public motor garage licensed premises theatre cinematograph theatre or other place of amusement shop or business premises shall be erected on the premises and no buildings now or at any time to be erected thereon shall at any time be used except as private dwellinghouses only but no objection shall be made to user of the premises at present erected on the land as a private residential hotel.
> 2. Any dwellinghouse when erected on the said premises shall be of the value of £900 at least in prime cost of materials and labour exclusive of any outbuildings stabling or motor garage.
> 3. The front wall of any dwellinghouses to be erected on the premises shall range and be set back from Poynders Road within the boundary line to be fixed by the London County Council and in accordance with the provisions of the Housing and Town Planning Scheme of the District.

Other covenants require the permission of the freeholder for certain redevelopments (i.e. placing a structure close to the property edge):

> A Conveyance of the land in this title and other land dated 10 March 1914 made between (1) [Person A] (Vendor) and (2) [Person B] contains the following covenants: Covenant by Purchasers with Vendor his heirs and assigns that the Purchasers their heirs and assigns would not place or suffer to be placed any building whatsoever other than walls or fences under 6 feet in height on any part of the lands thereby conveyed nearer than 30 feet to the road called Lambton Road without the previous consent in writing of [Person A] or the person or persons claiming in succession to them.

In general, however, a covenant against the making of improvements without consent is subject to the provision that consent shall not be unreasonably withheld. This was determined by **Section 19(2) of the Landlord and Tenant Act 1927**:

> In all leases whether made before or after the commencement of this Act containing a covenant condition or agreement against the making of improvements without a

> licence or consent, such covenant condition or agreement shall be deemed, notwithstanding any express provision to the contrary, to be subject to a proviso that such licence or consent is not to be unreasonably withheld; but this proviso does not preclude the right to require as a condition of such licence or consent the payment of a reasonable sum in respect of any damage to or diminution in the value of the premises or any neighbouring premises belonging to the landlord, and of any legal or other expenses properly incurred in connection with such licence or consent nor, in the case of an improvement which does not add to the letting value of the holding, does it preclude the right to require as a condition of such licence or consent, where such a requirement would be reasonable, an undertaking on the part of the tenant to reinstate the premises in the condition in which they were before the improvement was executed.

As described by Burn, Cartwright and Cheshire (2011), the word "improvements" refers to improvements from the point of view of the tenant, and the statute applies even though what he proposes to do, for example, the demolition of part of the main structure of a building, will temporarily diminish the value of the premises (see *Lambert v Woolworth & Co Otd, 1938*).

The third class of covenants relate to the **joint use of infrastructure** such as access roads:

> The land is subject to the following reservations contained in a Conveyance of the freehold estate in the land in this title and other land dated 10 October 1878 made between (1) [Person A] and (2) [Person B]: Reserving nevertheless to the said [Person A] his heirs and assigns owner or owners for the time being of any messuage to be erected on the adjoining land on the South of the said premises thereby granted the right of using a Drain already constructed under the South side of the back yard of the Southernmost of the said messuages thereby granted to connect the drain from the said messuage so to be erected on the adjoining land on the South of the said premises thereby granted as aforesaid with the said Drain the use whereof was thereinbefore granted by the said [Person A] with liberty for the said [Person A] his heirs and assigns tenants or occupiers and his and their servants and workmen at all reasonable times to enter the back-yard of the Southernmost of the said messuages thereby granted for he purpose of connecting and repairing such Drain such Drain in the said backyard to be kept in repair when and so soon as the same should be used by the said [Person A] his heirs or assigns tenants or occupiers at the joint expense of the said [Person A] his heirs and assigns and of the said [Person B] his heirs and assigns and each of them would pay to the other of them on demand one moiety of the expenses incurred by the other of them in repairing such last mentioned Drain.

Unless there is specific agreement to the contrary, a tenant is free to grant his interest to a third party, either by assignment or by underlease, as described in Burn, Cartwright and Cheshire (2011). A fourth set of covenants we sometimes encountered therefore requires leaseholders to

obtain the freeholder's permission to **sublet the property**, i.e. to rent it out to somebody else. These requirements usually stipulate that the freeholder cannot "unreasonably withhold" consent to a sublet, and sometimes allow the freeholder to charge a fee for registering a sublet. These terms for subletting property are regulated in **Section 19(1) of the Landlord and Tenant Act 1927**, which provides as follows:

> In all leases whether made before or after the commencement of this Act containing a covenant condition or agreement against assigning, under-letting, charging or parting with possession of demised premises or any part thereof without licence or consent, such covenant condition or agreement shall, notwithstanding any express provision to the contrary, be deemed to be subject
>
> 1. to a proviso to the effect that such licence or consent is not to be unreasonably withheld, but this proviso does not preclude the right of the landlord to require payment of a reasonable sum in respect of any legal or other expenses incurred in connection with such licence or consent; and
> 2. (if the lease is for more than forty years, and is made in consideration wholly or partially of the erection, or the substantial improvement, addition or alteration of buildings, and the lessor is not a Government department or local or public authority, or a statutory or public utility company) to a proviso to the effect that in the case of any assignment, under-letting, charging or parting with the possession (whether by the holders of the lease or any under-tenant whether immediate or not) effected more than seven years before the end of the term no consent or licence shall be required, if notice in writing of the transaction is given to the lessor within six months after the transaction is effected.

Furthermore, the **Landlord and Tenant Act 1988** places on the landlord the burden of showing that any refusal or the imposition of any conditions was reasonable. It also gives a tenant the right to sue for damages suffered as a result of a landlord's unreasonable refusal. Subsequent common law cases have further regulated the maximum fee that freeholders can charge for the granting of approval for a sublet. In *Holding and Management (Solitaire) Limited vs. Cherry Lilian Norton (LRX/33/2011)*, the court decided that a fee in excess of £40 + VAT was not merited.

A.1.G.1 Direct Evidence on Leasehold Covenants

In addition to our broad search for covenants across many individual leaseholds with different initial lease lengths and from different geographies, we also conduct a systematic analysis of covenants in a particular postcode of London, E16, located in the eastern part of the city (the former dockyards). This postcode was chosen because of the presence of leaseholds with significant heterogeneity in initial lease length.[17] For each of the 801 leaseholds transacting within this

[17] It is hard to establish the representativeness of the covenants in this particular postcode. In principle this exercise could be repeated for other parts of the country, though the £3 charge per title acquisition makes such an analysis hard

postcode in our sample period, we downloaded the full leasehold and freehold title (which sometimes registers the covenants on the leaseholds) from the Land Registry website. 273 transactions were of leaseholds with an initial length of 99 years, 152 with an initial length of 125 years, 147 with an initial length of 200 years and 229 with an initial length of 999 years. After manual inspection of these contracts we found 11 different classes of covenants. These are described below, together with an example from one leasehold including such covenant:

1. **Docks** - No construction or erection of docks without prior authorization. Example from Register EGL457462 (Leasehold for 120, Wards Wharf Approach, E16 2ER)
   In respect of the whole of the land assured by the above written Indenture that the Purchasers their Successors and assigns or the person or persons deriving title under them will not without the consent in writing of the London and India Dock Company formerly the Victoria London Dock Company first had and obtained make erect or construct or suffer to be made erected or constructed upon such land any dock of a similar nature or to be applied to the like purposes as the Victoria (London) Dock.

2. **Thames** - No execution of works without prior presentation of plans to the Conservators of the River Thames. Example from Register EGL457462 (Leasehold for 120, Wards Wharf Approach, E16 2ER)
   In respect of the land secondly described in the above written Indenture and thereby assured that the Purchasers their Successors and assigns or the person or persons deriving title under them will not execute or begin to execute any works upon the last mentioned land or any part thereof unless plans shewing the nature of the works proposed to be erected or executed shall have been deposited with the Conservators of the River Thames at their office and unless such plans shall have been approved on behalf of the said Conservators by their Secretary in writing before the proposed works shall be commenced Provided nevertheless that such approval shall not be unreasonably withheld.

3. **Nuisance** - Not to do anything that may be a nuisance to the Transferor. Example from Register EGL435316 (Leasehold for Lily Nichols House 6, Connaught Road, E16 2AD)
   The Transferee covenants with the Transferor (...) Not to do anything which shall be or may grow to be a nuisance or annoyance to the Transferor or any other person who is registered proprietor of any part of the Estate.

4. **Roadblock** - Not to obstruct any part of the Estate roads. Example from Register EGL435316 (Leasehold for Lily Nichols House 6, Connaught Road, E16 2AD)
   Not to park on or otherwise obstruct nor to erect any building or structure of any nature upon any part of the Estate Road.

5. **Build** - Not to erect structures or change existing ones. Example from Register EGL435316 (Leasehold for Lily Nichols House 6, Connaught Road, E16 2AD)
   Not for a period of two years from the date hereof without the prior written consent of the transferor

to conduct on a large scale.

which shall not be unreasonably withheld or delayed:- (i) to construct or allow to be constructed any additional building structure or extension or lay any sewers or drains on any part of the Property; (ii) to make any alterations to any Buildings or the external appearance of any part of the Property

6. **Trees** - Not to alter/destroy any trees in the Estate. Example from Register EGL435316 (Leasehold for Lily Nichols House 6, Connaught Road, E16 2AD)
   Not to fell lop or top any tree situated within the Property without the prior written consent of the Local Planning Authority nor to remove or destroy any tree or shrub planted on the Property as part of any landscaping scheme and to replace any such tree or shrub which may fail or die

7. **Parking** - Not to use the parking spaces for any other use than parking private vehicles. Example from Register EGL435316 (Leasehold for Lily Nichols House 6, Connaught Road, E16 2AD)
   Not to use the parking spaces on the Property save for the purpose of parking one private motor vehicle in each space.

8. **NoisyTrade** - Not to use the Estate for manufacture, trade and business that may be dangerous and/or noisy. Example from Register EGL281787 (8, Newland Street, E16 2DU)
   "No manufacture trade business or operations of a noisome dangerous or noisy kind shall be carried on in or upon the land or any building thereon and no building thereon shall be used as an hotel public house or tavern or for the sale of beer wines and spirits."

9. **Exhibition** - No use as exhibition space in excess of 2000 square meters of area in the next 25 years. Example from Register 432232 (101 Fishguard Way, E16 2RG)
   Not within 25 years of the date hereof to construct on and/or use the Property for any single purpose-built exhibition space in excess of 2000 square metres in area.

10. **Wharf** - No use of the premises for specific trades such as wharfing or building materials. Example from Register EGL441147 (The Reflection 2, Flat 11, E16 2GD)
    "AND the Council hereby for themselves their successors and assigns covenant with the Grantor his heirs executors administrators and assigns that the Council [. . .] their successors and assigns will not use or allow to be used the hereditaments and premises hereby conveyed or any part thereof directly or indirectly for the purposes of a trade of a brick lime cement pipe title slate builders material merchant Wharfinger or any similar trade without the consent in writing of the Grantor his heirs executors administrators or assigns successors in title to the hereditaments adjoining the hereditaments hereby conveyed on the East side thereof and known as Sankeys Barge House Wharf first had and obtained."

11. **Advertisement** - No use of the premises as advertising space. Example from Register EGL99625 (Dunedin House, 26, E162LA)
    No advertisement sign or display shall be erected on the land and premises hereby transferred or attached to the house erected thereon other than a name plate not exceeding eight inches by six inches in dimension giving particulars of the profession of the owner and at the appropriate times the usual signs giving notice of a proposed sale.

We inspected each of the 801 titles and determined which covenants were present for which leasehold. Appendix Figure A.2 shows the share of leaseholds of each initial lease length that have each covenant. We find no evidence in this analysis that covenants are any more restrictive on leasehold properties with shorter initial leases (99 years, 125 years) relative to leaseholds with longer initial leases (999 years).

A.2 Institutional Appendix - Singapore

Residential properties in Singapore can be classified into land titles and strata titles. Land title properties occupy land that is exclusive to the owner (like a detached house), whereas a strata title comprises units in multi-unit housing (flats or apartments) or in condominium developments. Owners of strata properties enjoy exclusive title only to the airspace of their individual unit. The land that the development is built on is shared by all the owners of the project, based on the share of the strata title unit owned by each owner. Owners are free to sell their individual unit. In order to sell the land, they will have to go via an "en bloc" sale, which requires a minimum of 80% of the owners' consent.[18]

A large fraction of the Singaporean housing stock consists of Housing and Development Board (HDB) properties, mostly in the form of flats. In total over 80% of Singapore's population lives in HDB flats, and 90% of them are fully owned. The HDB flats are part of a state-subsidized home ownership program and leases are often granted at below market values. We exclude these properties from our analysis and focus instead on the private market, where transaction prices reflect market values of the properties.

Initial lease lengths in Singapore are almost always either 99 or 999 years. The earliest land lease was issued in 1826 with a term of 999 years. There are also other types of less common lease structures. The first are private developments with 103-year leaseholds sold on freehold land. In addition, in November 2012 a plot of land at Jalan Jurong Kechil was the first to be sold for residential development under an initial 60-year lease agreement; though houses built there do not yet appear in our data.

Property taxes are independent of the form and duration of ownership. Property taxes are levied on the *Annual Value* (AV), the tax-authority assessed 1-year rental income of the property. For rental properties, the tax rate is set at 10% of AV; for owner-occupied properties, it rises from 0% on the first SG$6,000 to a marginal rate of 6% for AVs exceeding SG$65,000.[19] The rental income, and therefore the Annual Value, of a property is unaffected by the length of the lease under which the property is owned. Property transactions are also subject to stamp duty irrespective of the form and duration of ownership.[20] As with the U.K., the progressive nature of the tax in-

[18] 80% consent is necessary if the development is at least 10 years old and 90% consent is necessary if the development is less than 10 years old.

[19] Starting from January 1, 2014, property taxes were made more progressive.

[20] Stamp duties are transaction taxes, and are assessed on the purchase value of the property. The first SG$180,000 are assessed at 1%, the next $180,000 at 2%, and each additional increase in the sales prices at 3%.

creases the relative value of short-maturity leasehold properties which are cheaper and therefore taxed at the lower marginal rate.

Singapore allows home buyers to use their pension contributions to pay off their mortgage. Recently, it was also allowed to use such contributions to pay off a certain portion of the down payment. However, for any leasehold property, if the number of years remaining is less than 60 years at the time of transaction, home buyers are not allowed to use pension contributions to buy their properties. Consistent with this, banks have a similar restrictions for mortgage lending.

A.3 U.K. Leasehold Discounts - Houses

In Section III.C we analyze price differences between leaseholds of varying maturity and freeholds for U.K. flats. In this section we show that the estimated price differences between leaseholds and freeholds are, if anything, larger in the transaction sample for U.K. houses. The bottom panel of Table I reports the composition of our sample of houses. We observe just above 6.5 million transactions between 2004 and 2013, almost all of which (95%) are transactions of freeholds. Most of the remaining leaseholds are concentrated at maturities below 125 years or above 700 years: around 300,000 transactions, or 4% of the sample, are for leaseholds with 700 or more years remaining. The number of transactions for shorter leases is much smaller, with around 0.8% below 125 years and only 0.2% between 125 and 200 years. Given the lack of data for intermediate maturities for houses, we focus on the very long maturities (700+ years remaining) and the short maturities (less than 125 years remaining) when analyzing house transactions. For houses, leaseholds are more geographically concentrated, clustering around Manchester and Newcastle. However, the overall number of transactions for houses is large, so that we have within-postcode variation in lease length in most postcodes in our sample, even if one contract type comprises the majority of the sample. Overall, relative to the transaction sample for flats, for transactions of houses we have less variation across contracts, in particular for leases between 125 years and 700 years. This was the reason to focus on flats in the main body of the paper.

To better understand the differences in observable characteristics between leasehold and freehold houses, Appendix Figure A.29 shows the residuals of a regression of each hedonic characteristic on postcode fixed effect for each group of remaining lease length. This is is analogous to Figure I in the main paper, and shows only relatively small differences in observable characteristics between freeholds and leaseholds of different maturity. We next estimate the relative prices paid for leaseholds of varying remaining maturity and freeholds for houses in England and Wales. Given the lack of transactions of leaseholds with intermediate maturities, we construct the following three *MaturityGroups* for leasehold houses: 80-99 years, 100-124, and 700+ years groups. We then estimate regression (A.1) below. The unit of observation is a transaction i of a house of type g (detached, semi, terraced) in 3-digit post code h at time t. We assign each leasehold with remaining maturity $T_{i,t}$ to one of the $MaturityGroup_j$ buckets depending on the number of years remaining on the lease at the point of sale. The excluded category are freeholds, so that the β_j coefficients

capture the log-discount of leaseholds with that maturity relative to otherwise similar freeholds.

$$log(Price_{i,h,t,g}) = \alpha + \sum_{j=1}^{3} \beta_j \mathbf{1}_{\{T_{i,t} \in MaturityGroup_j\}} + \gamma Controls_i + \xi_h \times \psi_t \times \phi_g + \epsilon_{i,h,t,g} \tag{A.1}$$

Appendix Table A.2 shows the results. The estimated discounts between leaseholds and freeholds are larger for houses than for flats: leaseholds of 80-99 years remaining length trade at a discount of 31% relative to freeholds, and leaseholds with 100-124 years remaining trade at a 26% discount. Very long leaseholds with more than 700 years remaining trade for a small discount of around 1%. While larger in magnitude, the results are in line with the results for flats, though they are somewhat less informative given the limited use of short leaseholds for houses as well as the geographic concentration of the leaseholds discussed above.

A.4 Financing Frictions - Calibration

It is beyond the scope of this paper to provide a full general equilibrium model of housing in the presence of collateral and borrowing constraints. Instead we consider a simple deviation from the constant-discount-rate model in Section V to quantify the impact of a reduced form collateral constraint on leasehold discounts. We assume that for the last $\bar{T}$ years of lease maturity the property has lower collateral value modeled via an effective rent for the last $\bar{T}$ years that is a fraction $(1-\alpha)$ of the true rent.[21] The value of the lease is given by:

$$\begin{aligned} P_t^T &= \int_t^{t+T} e^{-\rho(s-t)} D_t e^{g(s-t)} (1 - \alpha \mathbf{1}_{\{s > t+T-\bar{T}\}}) ds \\ &= \int_t^{t+T} e^{-\rho(s-t)} D_t e^{g(s-t)} ds - \alpha \int_{t+T-\bar{T}}^{t+T} e^{-\rho(s-t)} D_t e^{g(s-t)} ds + \\ &\quad + \mathbf{1}_{\{T<\bar{T}\}} \alpha \int_{t+T-\bar{T}}^{t} e^{-\rho(s-t)} D_t e^{g(s-t)} ds \\ &= \frac{D_t}{\rho - g} \left[1 - e^{-(\rho-g)T} - \alpha \left(e^{-(\rho-g)(T-\bar{T})} - e^{-(\rho-g)T} \right) + \mathbf{1}_{\{T<\bar{T}\}} \alpha \left(e^{-(\rho-g)(T-\bar{T})} - 1 \right) \right] \end{aligned} \tag{A.2}$$

Notice that the first multiplicative term in the equation above is simply the valuation of the freehold under the Gordon growth formula $\left(\frac{D_t}{\rho-g}\right)$. The first term inside the squared bracket $\left(1 - e^{-(\rho-g)T}\right)$ is the Gordon growth price adjustment for the value of a T-maturity leasehold. The second term inside the squared bracket is the loss in value for the $T > \bar{T}$ maturity leasehold due to the frictions. Notice that this term is zero whenever there are no frictions ($\alpha = 0$ and or $\bar{T} = 0$). The last term inside the squared bracket captures the notion that if a leasehold has already

[21] This loss corresponds to the per-period shadow value of liquidity (i.e., the per-period cost to the buyer of having to use own resources or a shorter maturity mortgage). Alternatively, we can interpret α as the total loss in value once the leasehold reaches 60 years of remaining maturity due to the fact that new potential buyers will no longer have access to long-maturity mortgages and might need to make a larger downpayment.

less than $\bar{T}$ years left than it would be valued at:

$$P_t^T = \frac{D_t(1-\alpha)}{\rho - g}(1 - e^{-(\rho-g)T}),$$

so that the leasehold is valued as if rents were only a fraction $(1-\alpha)$ of the original ones. Notice that the value of the freehold is unaffected by the frictions because by definition it never loses its collateral value: $P_t = \lim_{T\to\infty} P_t^T = \frac{D_t}{\rho-g}$. The model-implied leasehold discount is given by:

$$Disc_t^T = e^{-(\rho-g)T} + \alpha\left(e^{-(\rho-g)(T-\bar{T})} - e^{-(\rho-g)T}\right) - \mathbf{1}_{\{T<\bar{T}\}}\,\alpha\left(e^{-(\rho-g)(T-\bar{T})} - 1\right).$$

Let us focus on the case in which $T > \bar{T}$, i.e. if we are valuing a leasehold with maturity beyond the problematic threshold. Notice the following effects:

1. $\frac{\partial Disc_t^T}{\partial \alpha} > 0$, the discount increases the greater the per-period collateral benefit.
2. $\frac{\partial Disc_t^T}{\partial \bar{T}} > 0$, the discount increases whenever the threshold for financing increases.
3. $\frac{\partial Disc_t^T}{\partial \alpha \partial T} < 0$ and $\lim_{T\to\infty} \frac{\partial Disc_t^T}{\partial \alpha} = 0$, the marginal effect of the loss in collateral value on the discount decreases with maturity of the lease and is zero in the limit of very long leases.

The last property is the most relevant for our robustness exercise. It states that no matter how high the frictions are ($\uparrow \alpha$), their effect decreases with the length of the lease. This effect makes the frictions quantitatively too small to explain the observed discounts, especially for long term leases. For example, if we set $\bar{T} = 60$ and we consider a 200 year lease even a high value of α of 15% leaves the long-run discount rate estimate largely unchanged, with only a slight increase to 2.75% from the benchmark estimate of 2.6%. Intuitively, a lease that has 200 years left today will only incur direct losses of its collateral value 140 years from now, when the lease will have 60 years left.

A.5 Real Rental Growth: Data Sources

In order to calibrate the parameter governing rent growth (g), we estimate the average real growth rate of rents directly from rental indexes. The estimated real growth rate of rents is low for both the U.K. and for Singapore, as well as for the U.S., which we add to compare our estimates with those existing in the literature. We obtain an estimate of $g = 0.17\%$ for Singapore and a somewhat higher estimate of $g = 0.62\%$ for the U.K.. For the U.S., we estimate $g = 0.53\%$, an estimate in line with that of Campbell et al. (2009), who obtain a median growth rate of 0.4% per year. Similarly, Ambrose, Eichholtz and Lindenthal (2013) find very low real rental growth in a long time series of rents in Amsterdam. We calibrate g to a conservative 0.7%.

We describe here the sources of data used for each estimate: the rental index and inflation series.

- For the U.S. we follow Favilukis, Ludvigson and Nieuwerburgh (2010) and compute rent growth using the BLS shelter index (the component of CPI related to shelter, item CU.S.R0000SAH1 from the Federal Reserve Bank of St. Louis). We obtain the CPI series from the same source, item CPIAUCSL. Our sample covers the years 1953-2013.
- For England and Wales we use the CPI component "Actual rents for housing" (series D7CE) from the Office of National Statistics as a rental index, and the CPI series from the same source (series D7BT). Our sample covers the years 1996-2013.
- For Singapore we obtain a time series of rental indices for the whole island from the Urban Redevelopment Authority (the official housing arm of the government: ura.gov.sg), and use the CPI series from the National Statistical Office. Our sample covers the years 1990-2012.

A.6 Risk Premia: Some Theoretical Details

Consider a claim to a positive risky cash flow at time T, denoted D_T. The present value at time t is the expected cash flow $E_t[D_T]$ discounted with some appropriate discount factor $R_{t,t+T}$:

$$P_t^{D_T} = \frac{E_t[D_T]}{R_{t,t+T}}. \tag{A.3}$$

The price of a safe security that pays 1 for sure at maturity T is: $P_t^{1_T} = 1/R^f_{t,t+T}$, where $R^f_{t,t+T}$ is the total return on the safe security when held to maturity. We can decompose $R_{t,t+T}$ into a discount factor that would be applied even if D_T were certain, and an additional discount that compensates the agents for risk, the risk premium $RP_{t,t+T}$: $R_{t,t+T} = R^f_{t,t+T} + RP_{t,t+T}$. Asset pricing theory relates the discount factors $R_{t,t+T}$ and $R^f_{t,t+T}$ to a "stochastic discount factor" (SDF) $\xi_{t,t+T}$ that reflects marginal utility in different states of the world. Assets are priced according to:

$$P_t^{D_T} = E_t[\xi_{t,t+T} D_T], \tag{A.4}$$

The values of $R_{t,t+T}$, $RP_{t,t+T}$, and $\xi_{t,t+T}$ are related via the formulas below:

$$R^f_{t,t+T} = E_t[\xi_{t,t+T}]^{-1}, \tag{A.5}$$

$$RP_{t,t+T} = -\frac{Cov_t[\xi_{t,t+T}, \tilde{R}_{t,t+T}]}{Var[\xi_{t,t+T}]} \frac{Var[\xi_{t,t+T}]}{E_t[\xi_{t,t+T}]} \equiv \beta_{t,t+T} \lambda_{t,t+T}. \tag{A.6}$$

where $\tilde{R}_{t,t+T} = D_T / P_t^{D_T}$ is the stochastic return to maturity for investing in the risky asset.

The risk-free component of the discount factor is related to the inverse of the expectation of the long-term SDF, i.e. long-term marginal utility growth. The risk premium has the opposite sign to the covariance between the stochastic discount factor and the cash flow, $Cov_t[\xi_{t,t+T}, D_T]$.[22] A claim that pays a higher cash flow in states of the world when extra resources are less valuable, i.e. when

[22] Recall that in this case $sign\left(Cov_t[\xi_{t,t+T}, \tilde{R}_{t,t+T}]\right) = sign\left(Cov_t[\xi_{t,t+T}, D_T]\right)$, since $\tilde{R}_{t,t+T} = D_T / P_t^{D_T}$.

marginal utility $\xi_{t,t+T}$ is low, is less desirable and thus discounted at a higher rate. Such an asset is risky, and its risk premium is positive. The risk premium ($RP_{t,t+T}$) can be further decomposed into an asset-specific "quantity of risk" term ($\beta_{t,t+T}$), which summarizes how strongly the payoff co-varies with the stochastic discount factor, and a common "price of risk" term ($\lambda_{t,t+T}$), that only depends on $\xi_{t,t+T}$ and summarizes the compensation required for each unit of risk at that horizon.

We now provide detailed derivations. Starting with the fundamental valuation equation $P_t^{D_T} = E_t[\xi_{t,t+T} D_T]$ and the definition of return $\tilde{R}_{t,t+T} = \frac{D_T}{P_t^{D_T}}$, we have:

$$1 = E_t[\xi_{t,t+T}\tilde{R}_{t,t+T}] = E_t[\xi_{t,t+T}]E_t[\tilde{R}_{t,t+T}] + Cov_t[\xi_{t,t+T}, \tilde{R}_{t,t+T}].$$

Re-arranging we obtain:

$$E_t[\tilde{R}_{t,t+T}] = E_t[\xi_{t,t+T}]^{-1}\left(1 - Cov_t[\xi_{t,t+T}, \tilde{R}_{t,t+T}]\right) = R^f_{t+t+T} - Cov_t[\xi_{t,t+T}, \tilde{R}_{t,t+T}]E_t[\xi_{t,t+T}]^{-1},$$

where the last equality follows from the relation $R^f_{t+t+T} = E_t[\xi_{t,t+T}]^{-1}$. Finally, we re-arrange the definition of returns, take conditional expectations, and substitute in the above derivation for expected returns to write:

$$\begin{aligned} P_t^{D_T} =& \frac{E_t[D_T]}{E_t[\tilde{R}_{t,t+T}]} \\ =& \frac{E_t[D_T]}{R^f_{t+t+T} - Cov_t[\xi_{t,t+T}, \tilde{R}_{t,t+T}]E_t[\xi_{t,t+T}]^{-1}} \\ =& \frac{E_t[D_T]}{R^f_{t+t+T} - \frac{Cov_t[\xi_{t,t+T}, \tilde{R}_{t,t+T}]}{Var_t[\xi_{t,t+T}]}\frac{Var_t[\xi_{t,t+T}]}{E_t[\xi_{t,t+T}]}}, \end{aligned}$$

which provides the main relations by defining:

$$\begin{aligned} R_{t,t+T} &\equiv E_t[\tilde{R}_{t,t+T}]; \\ RP_{t,t+T} &\equiv \beta_{t,t+T}\lambda_{t,t+T}; \\ \beta_{t,t+T} &\equiv -\frac{Cov_t[\xi_{t,t+T}, \tilde{R}_{t,t+T}]}{Var_t[\xi_{t,t+T}]}; \\ \lambda_{t,t+T} &\equiv \frac{Var_t[\xi_{t,t+T}]}{E_t[\xi_{t,t+T}]}. \end{aligned}$$

We next specialize this classic set-up of asset pricing theory to the case of leasehold and freeholds considered in this paper. The difference in price between the freehold and the leasehold of maturity T, $P_t - P_t^T$, is the price today of a claim to the freehold T periods from now. In brief, it is a claim today to a single positive risky cash flow, P_{t+T}, T periods from now. We can then apply Equation A.3 to this set-up to write $P_t - P_t^T = \frac{E_t[P_T]}{R_{t,t+T}}$, and recalling the definition of discounts

$Disc^T = \frac{P_t^T}{P_t} - 1$, we obtain the general relationship:

$$Disc^T = -\frac{E_t[P_T]/P_t}{R_{t,t+T}}, \tag{A.7}$$

This equation is a generalization of the Gordon growth model used in the main body of the paper. That model can be recovered by imposing that the discount factor is $R_{t,t+T} = e^{rT}$ and recalling that since rents grow according to $E_t[D_{t+T}] = D_t e^{gT}$, we obtain $P_T/P_t = e^{gT}$.

We can further decompose the discount factor $R_{t,t+T}$ into the risk free and risk premium components by applying Equations A.5 and A.6 to the case of leasehold and freehold. Our assumption in the main text that housing is risky at long horizons can be formalized here to correspond to the assumption that $Cov_t[\xi_{t,t+T}, \tilde{R}_{t,t+T}] > 0$, where in this case $\tilde{R}_{t,t+T}$ is the stochastic cumulative return between time t and $t+T$ of a claim to the freehold at time T. Intuitively this means that the value of a property freehold is expected to be low in bad states of the world (wars, consumption or natural disasters, etc...).[23]

In the main body of the paper we reported estimates in terms of annualized risk-free rate and risk premium. We formalize their definition below:

$$r^f_{t+T} = \frac{1}{T}\log(R^f_{t,t+T}) \tag{A.8}$$

$$r^{RP}_{t+T} = \frac{1}{T}\log\left(1 + \frac{RP_{t+T}}{R^f_{t,t+T}}\right) \tag{A.9}$$

Notice that r^f_{t+T} has the interpretation of the yield on a risk-free zero-coupon bond with maturity T. The interpretation of r^{RP}_{t+T} is less obvious, formally it is the risk-correction necessary such that $e^{r_{t,t+T}T} \equiv e^{(r^f_{t,t+T} + r^{RP}_{t,t+T})T} = R_{t,t+T}$. Since in the main body of the paper we only considered discount rates that do not vary with horizon, we adopted lighter notation by dropping the time subscripts to write, for example, r rather than $r_{t,t+T}$.

[23] Recall that in this case we have $\tilde{R}_{t,t+T} = \frac{P_{t+T}}{P_t - P_t^T}$, so that $0 < Cov_t[\xi_{t,t+T}, \tilde{R}_{t,t+T}] \iff Cov_t[\xi_{t,t+T}, P_{t+T}] > 0$.

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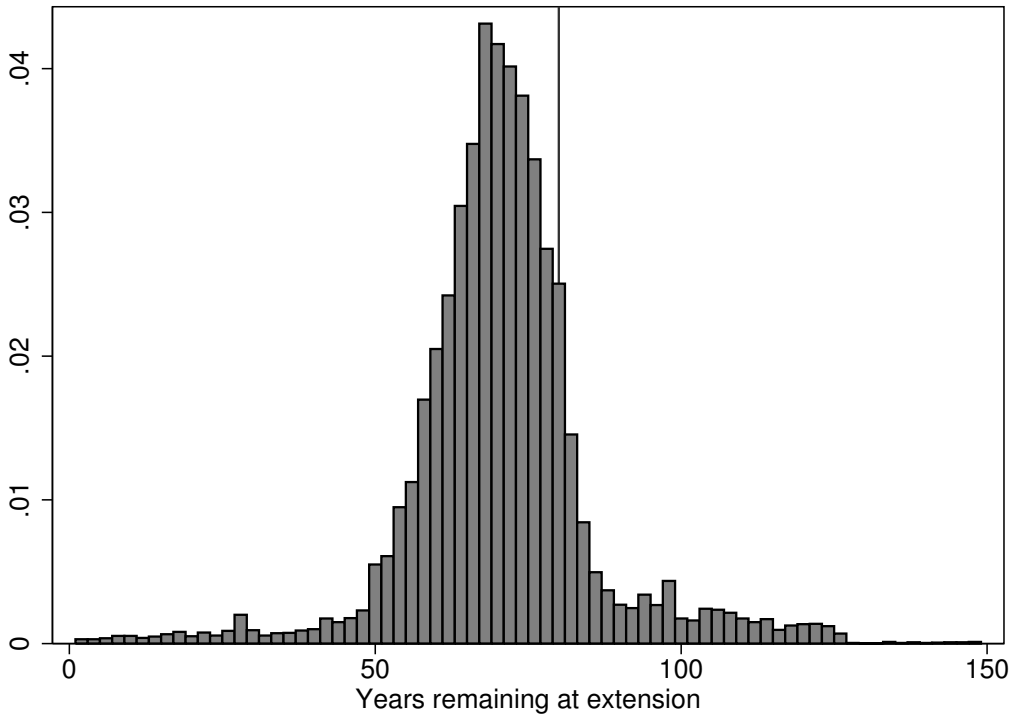
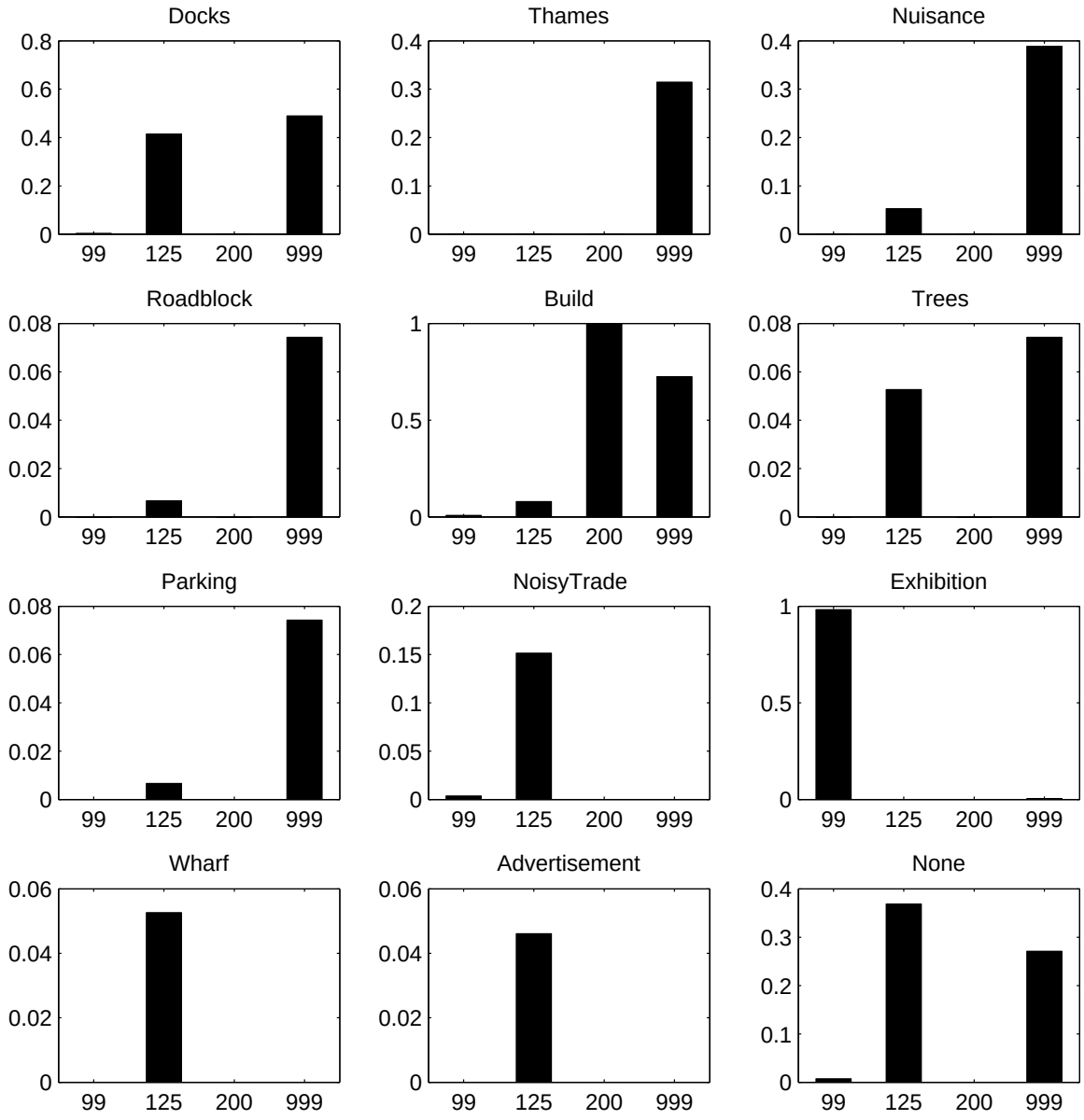
APPENDIX FIGURES

Figure A.1: Distribution of years remaining at lease extension



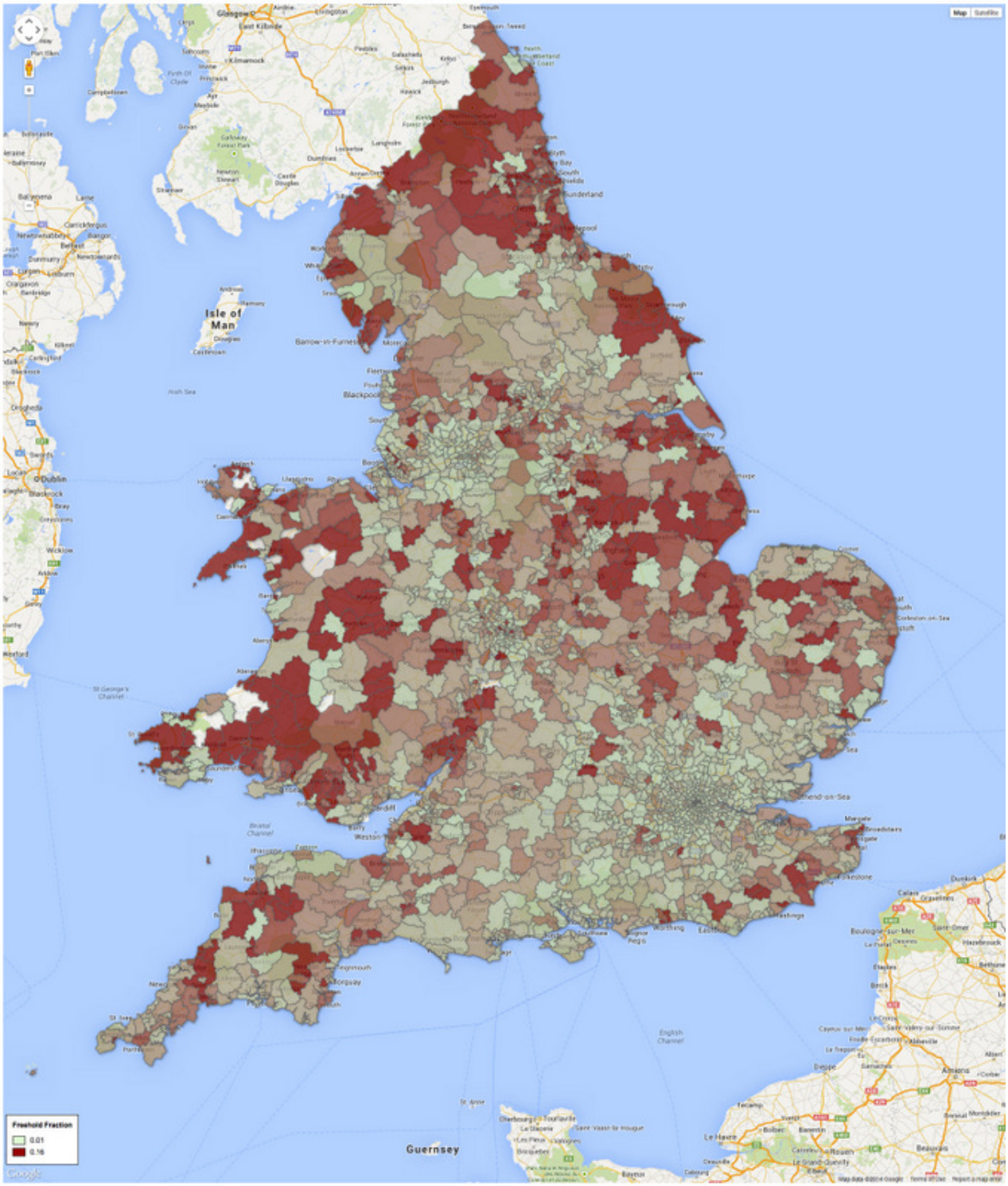
Note: Figure shows the distribution of the number of years remaining at the time of a lease extension for the subsample of 21,974 properties for which we can identify the time of the extension. The extensions are identified by finding all cases in which the same property transacts at least twice, in which different contracts appear across the various transactions. The years remaining at extension are the number of years remaining on the oldest contract as of the starting date of the next contract. The vertical bar corresponds to 80 years remaining.

Figure A.2: Distribution of covenants by initial lease length



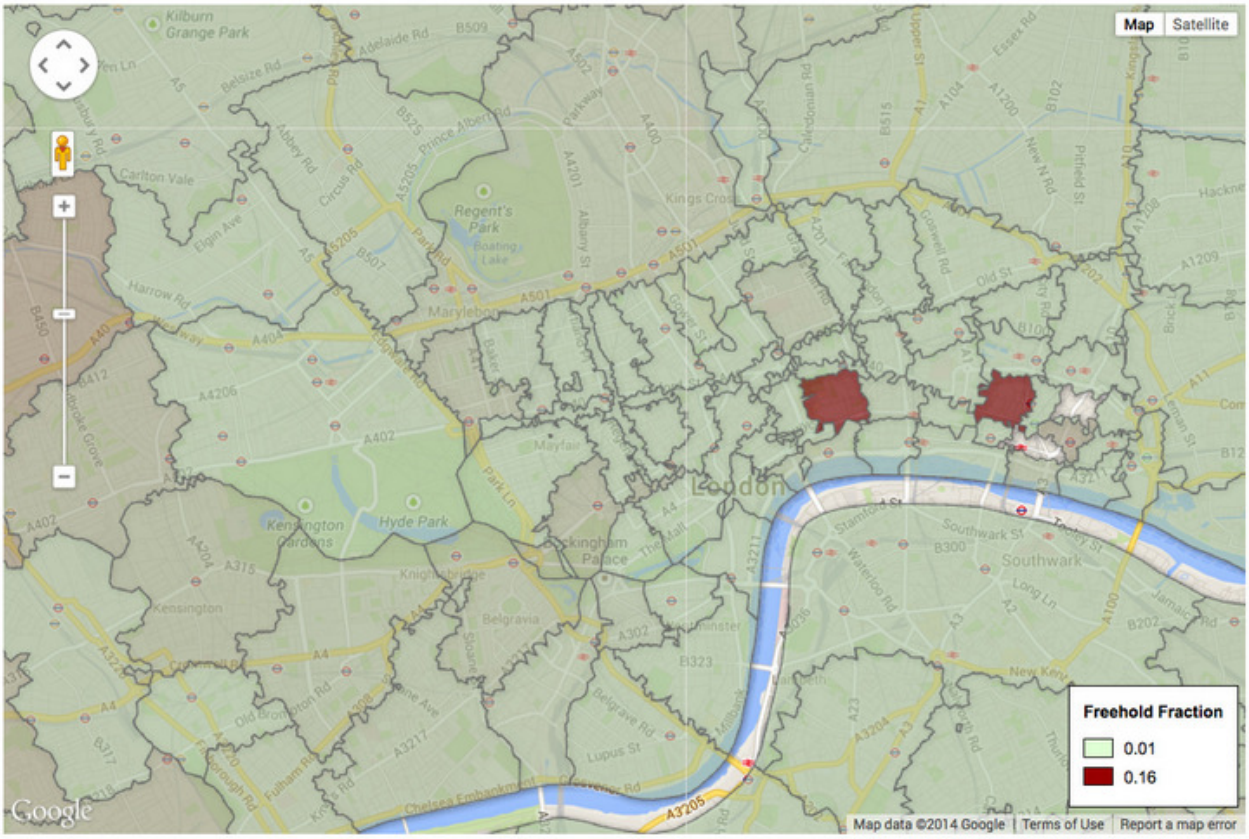
Note: Figure shows the share of leasehold contracts with a certain initial lease length in postcode E16 with the relevant covenant, defined in Appendix Section A.1.G.1. 273 transactions were of leaseholds with an initial length of 99 years, 152 with an initial length of 125 years, 147 with an initial length of 200 years and 229 with an initial length of 999 years.

Figure A.3: U.K. Flats: Fraction of Freeholds



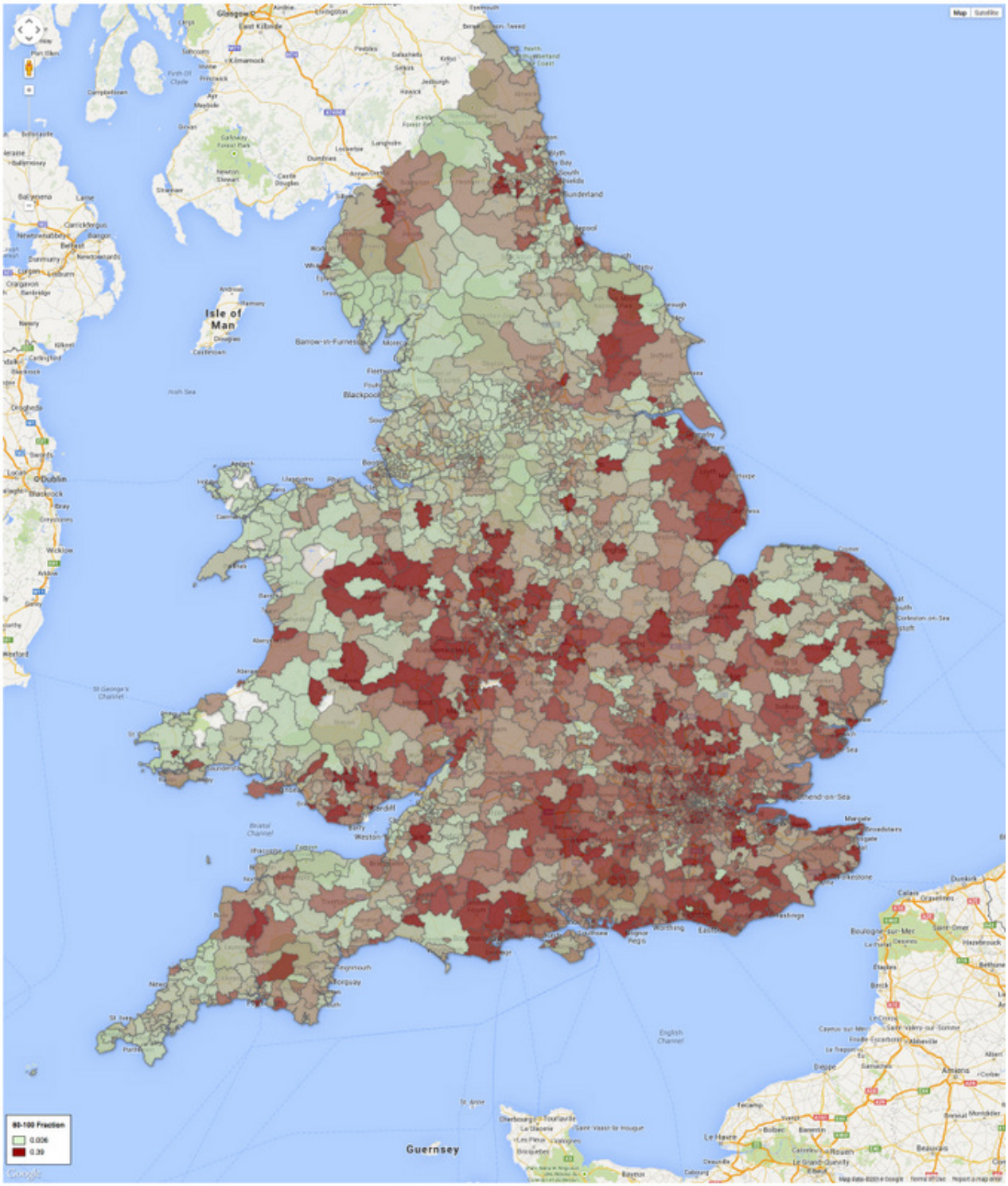
Note: Figure shows the fraction of freehold flats in each UK 3-digit postcode. Green and red correspond to the 10th and 90th percentile of the distribution of the fraction across postcodes.

Figure A.4: London Flats: Fraction of Freeholds



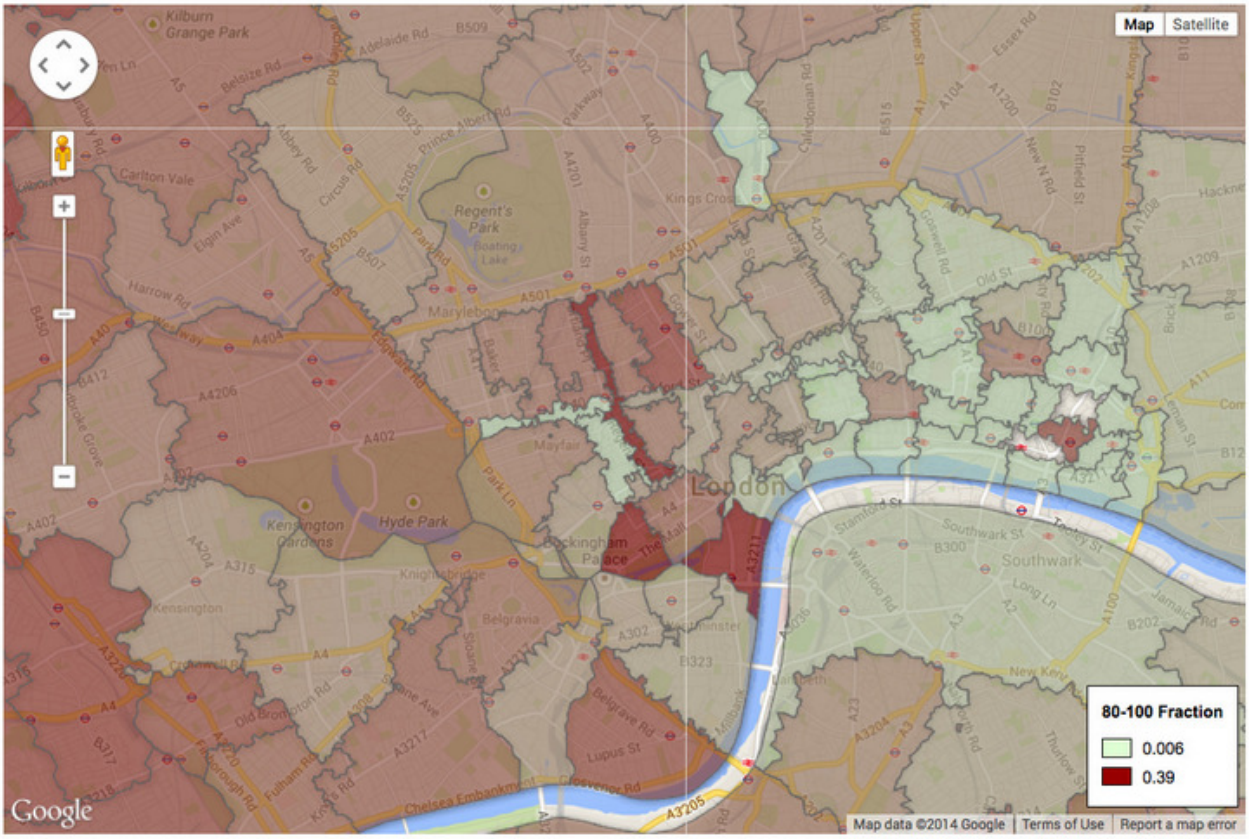
Note: Figure shows the fraction of freehold flats in each UK 3-digit postcode. Green and red correspond to the 10th and 90th percentile of the distribution of the fraction across postcodes. The figure zooms in on London.

Figure A.5: U.K. Flats: Fraction of 80-99 years leaseholds



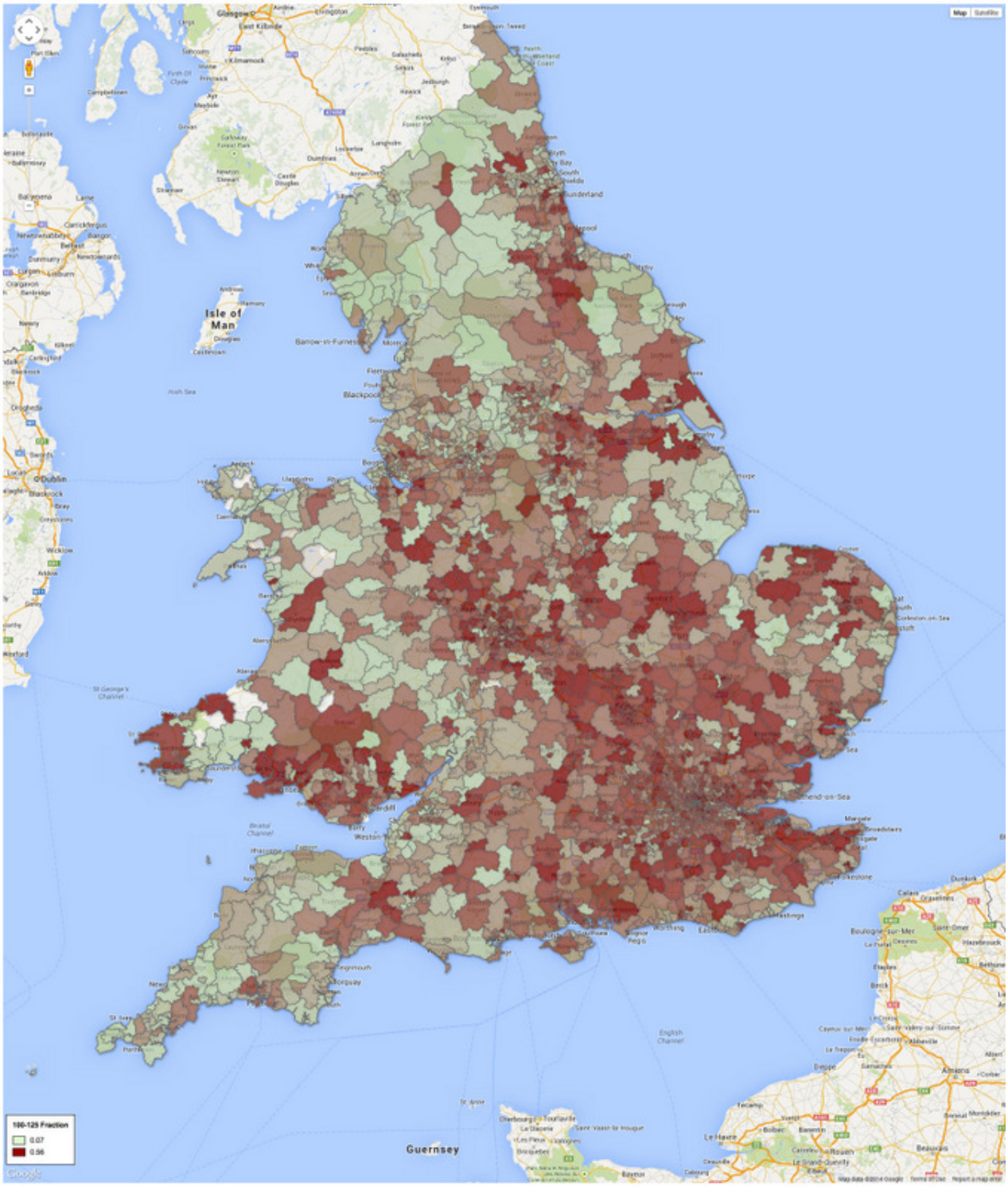
Note: Figure shows the fraction of flat transactions with 80-99 years remaining in each UK 3-digit postcode. Green and red correspond to the 10th and 90th percentile of the distribution of the fraction across postcodes.

Figure A.6: London Flats: Fraction of 80-99 years leaseholds



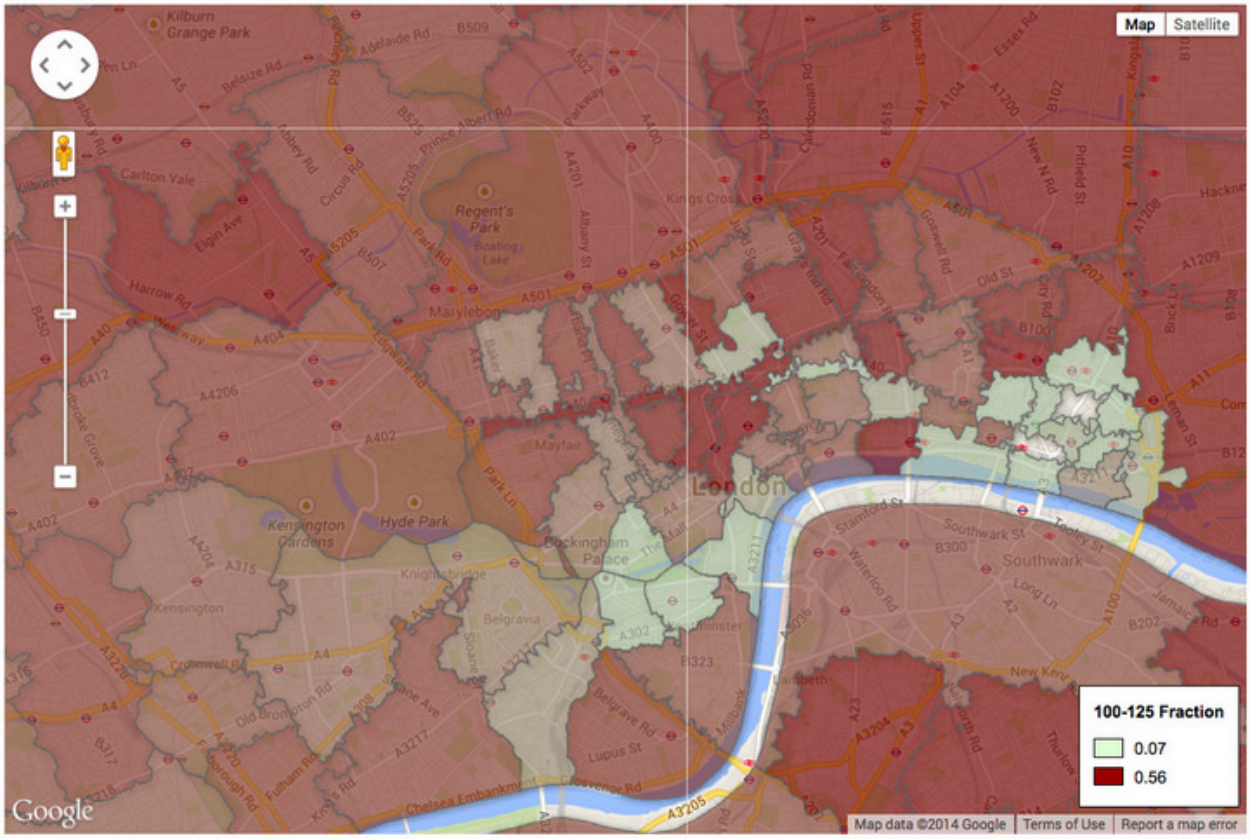
Note: Figure shows the fraction of flat transactions with 80-99 years remaining in each UK 3-digit postcode. Green and red correspond to the 10th and 90th percentile of the distribution of the fraction across postcodes. The figure zooms in on London.

Figure A.7: U.K. Flats: Fraction of 100-124 years leaseholds



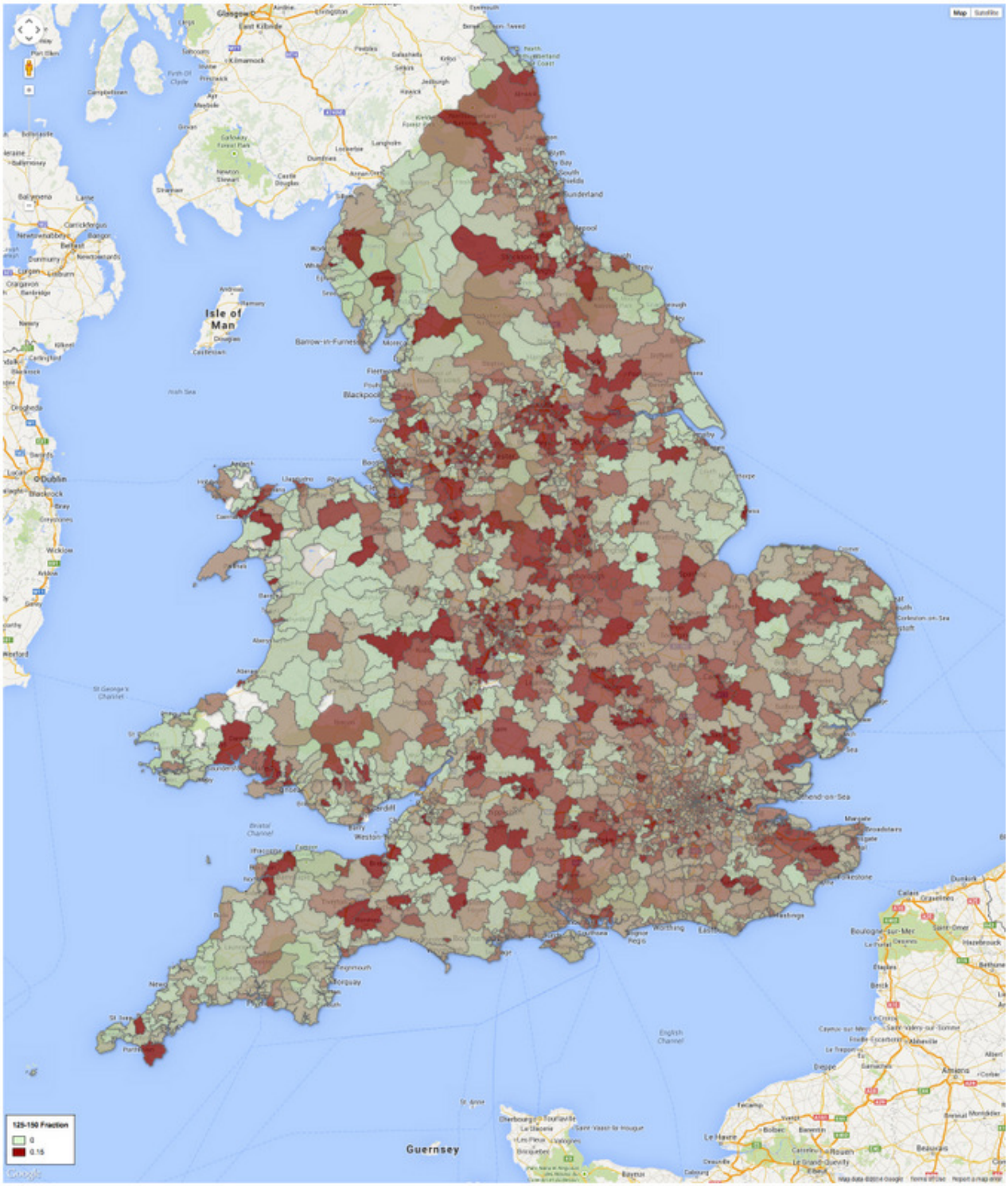
Note: Figure shows the fraction of flat transactions with 100-124 years remaining in each UK 3-digit postcode. Green and red correspond to the 10th and 90th percentile of the distribution of the fraction across postcodes.

Figure A.8: London Flats: Fraction of 100-124 years leaseholds



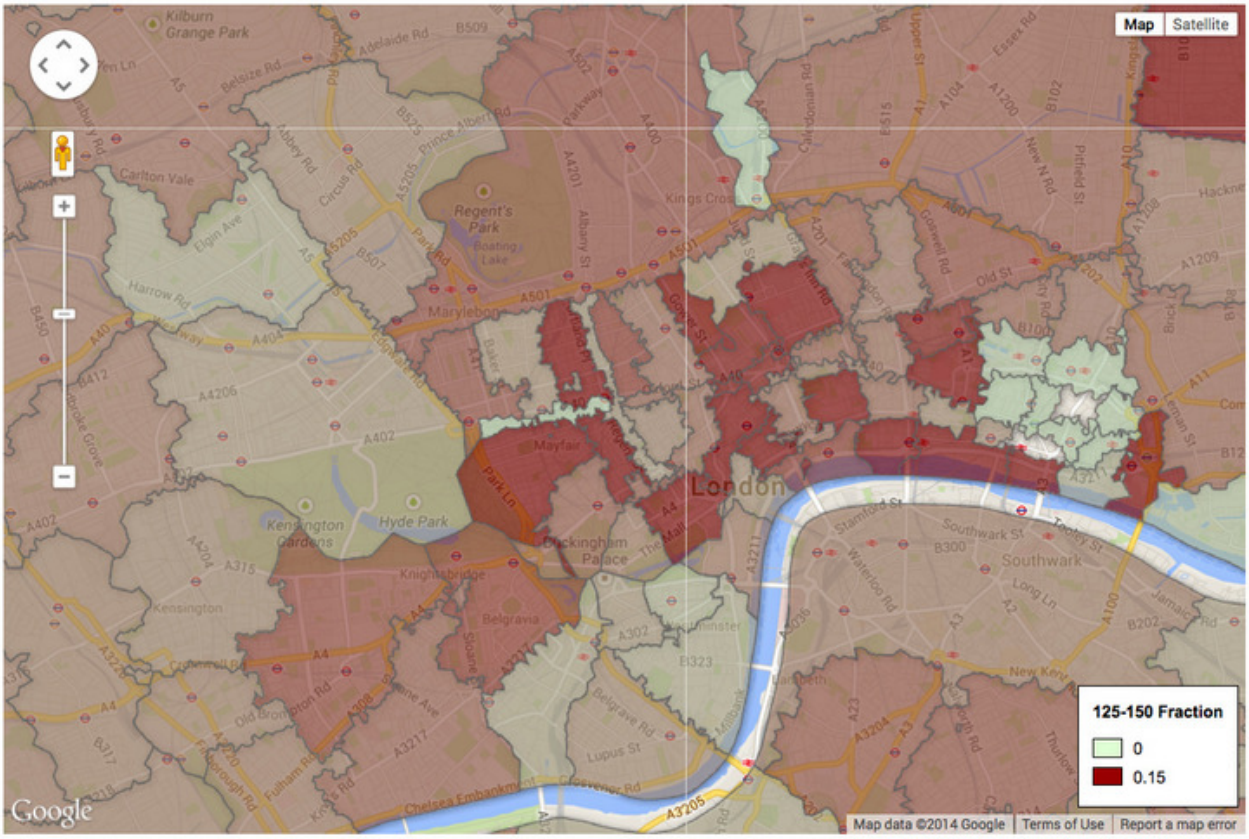
Note: Figure shows the fraction of flat transactions with 100-124 years remaining in each UK 3-digit postcode. Green and red correspond to the 10th and 90th percentile of the distribution of the fraction across postcodes. The figure zooms in on London.

Figure A.9: U.K. Flats: Fraction of 125-149 years leaseholds



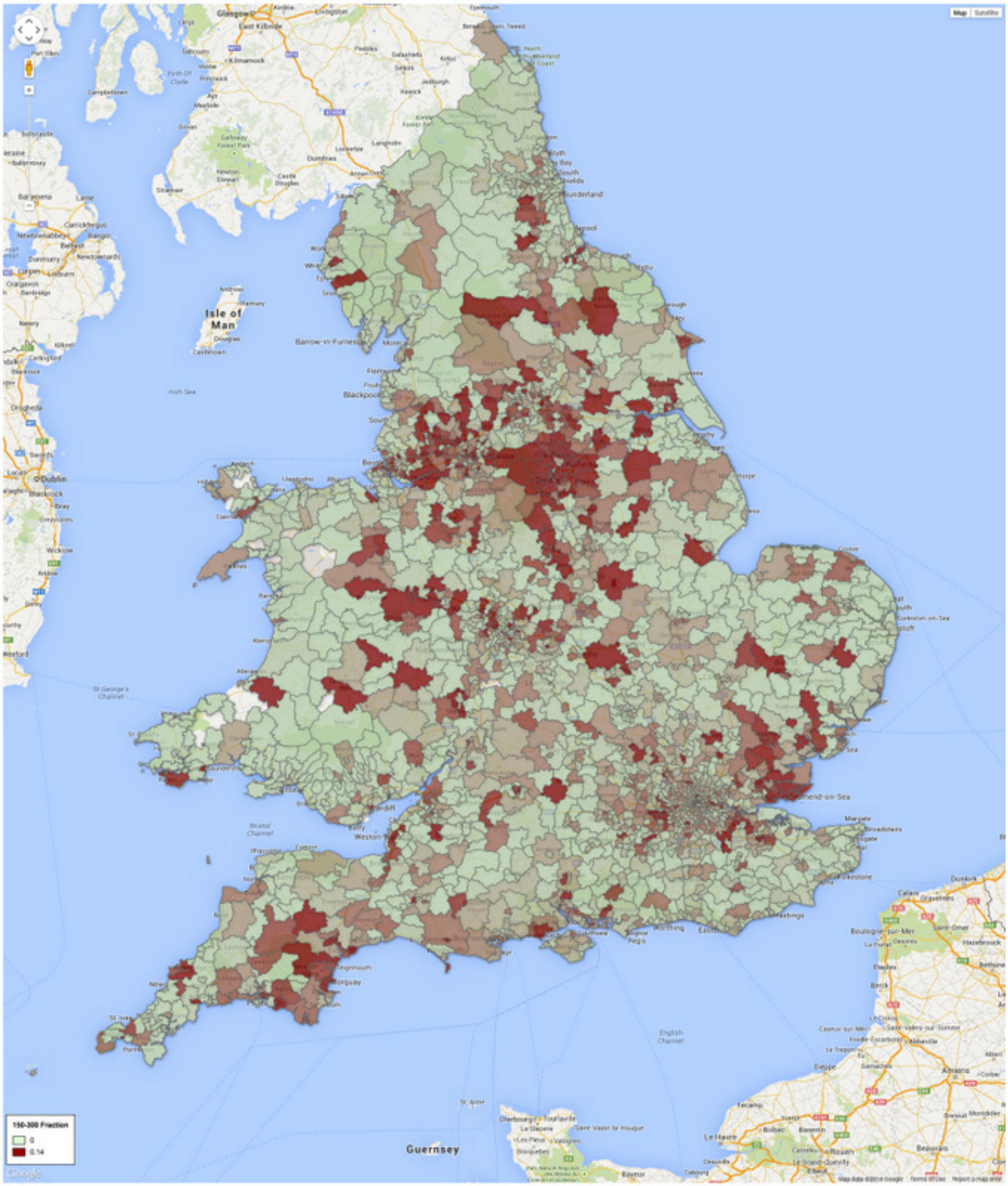
Note: Figure shows the fraction of flat transactions with 125-149 years remaining in each UK 3-digit postcode. Green and red correspond to the 10th and 90th percentile of the distribution of the fraction across postcodes.

Figure A.10: London Flats: Fraction of 125-149 years leaseholds



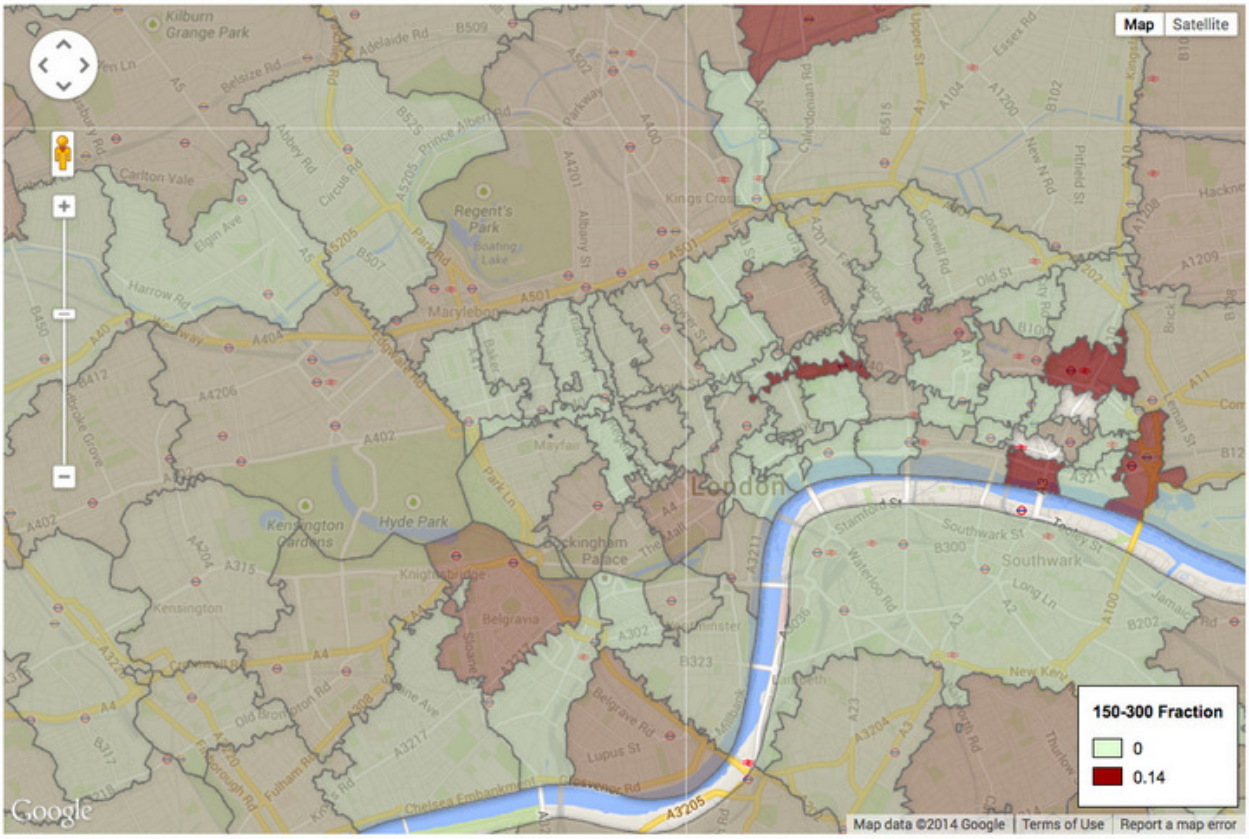
Note: Figure shows the fraction of flat transactions with 125-149 years remaining in each UK 3-digit postcode. Green and red correspond to the 10th and 90th percentile of the distribution of the fraction across postcodes. The figure zooms in on London.

Figure A.11: U.K. Flats: Fraction of 150-300 years leaseholds



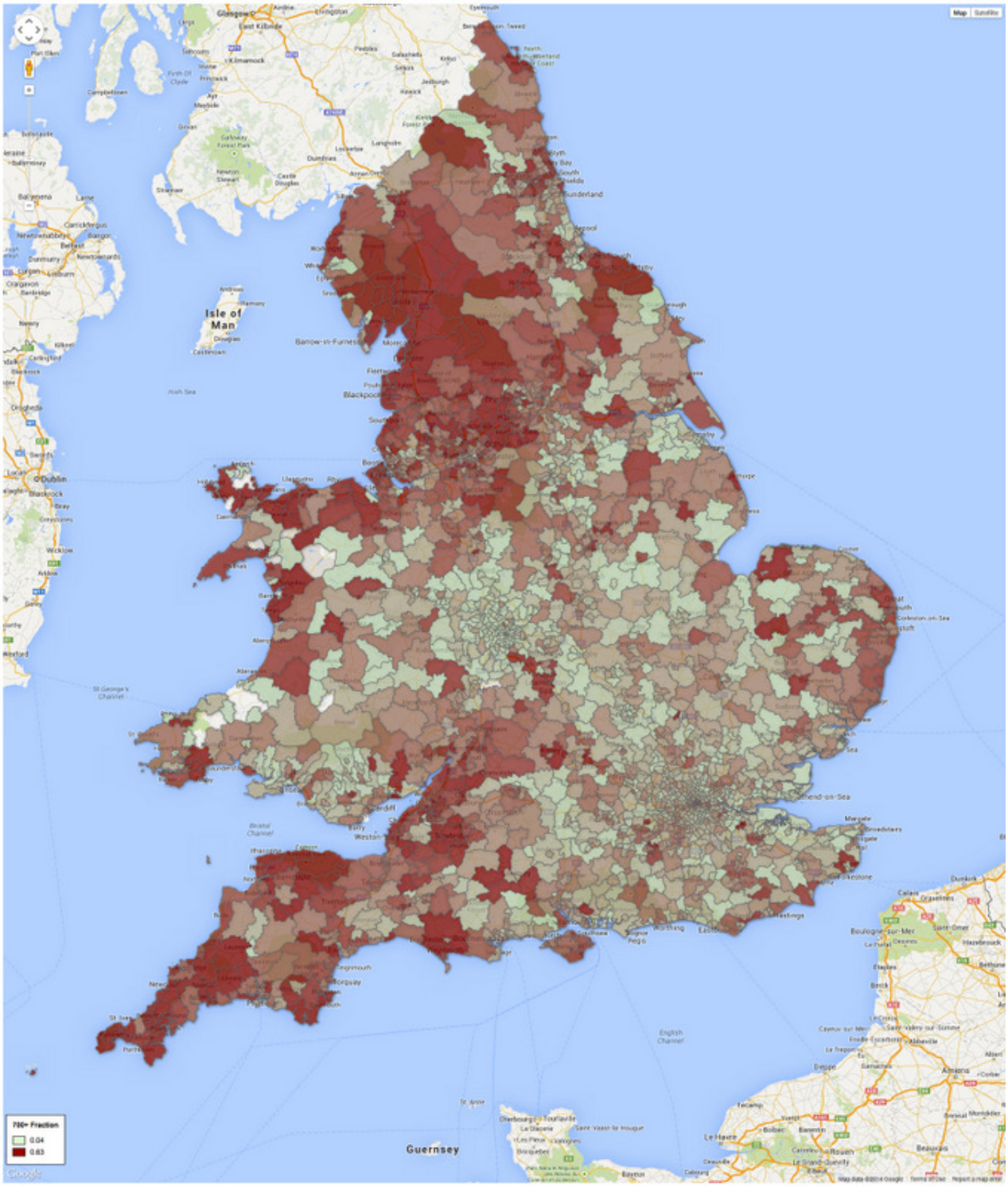
Note: Figure shows the fraction of flat transactions with 150-300 years remaining in each UK 3-digit postcode. Green and red correspond to the 10th and 90th percentile of the distribution of the fraction across postcodes.

Figure A.12: London Flats: Fraction of 150-300 years leaseholds



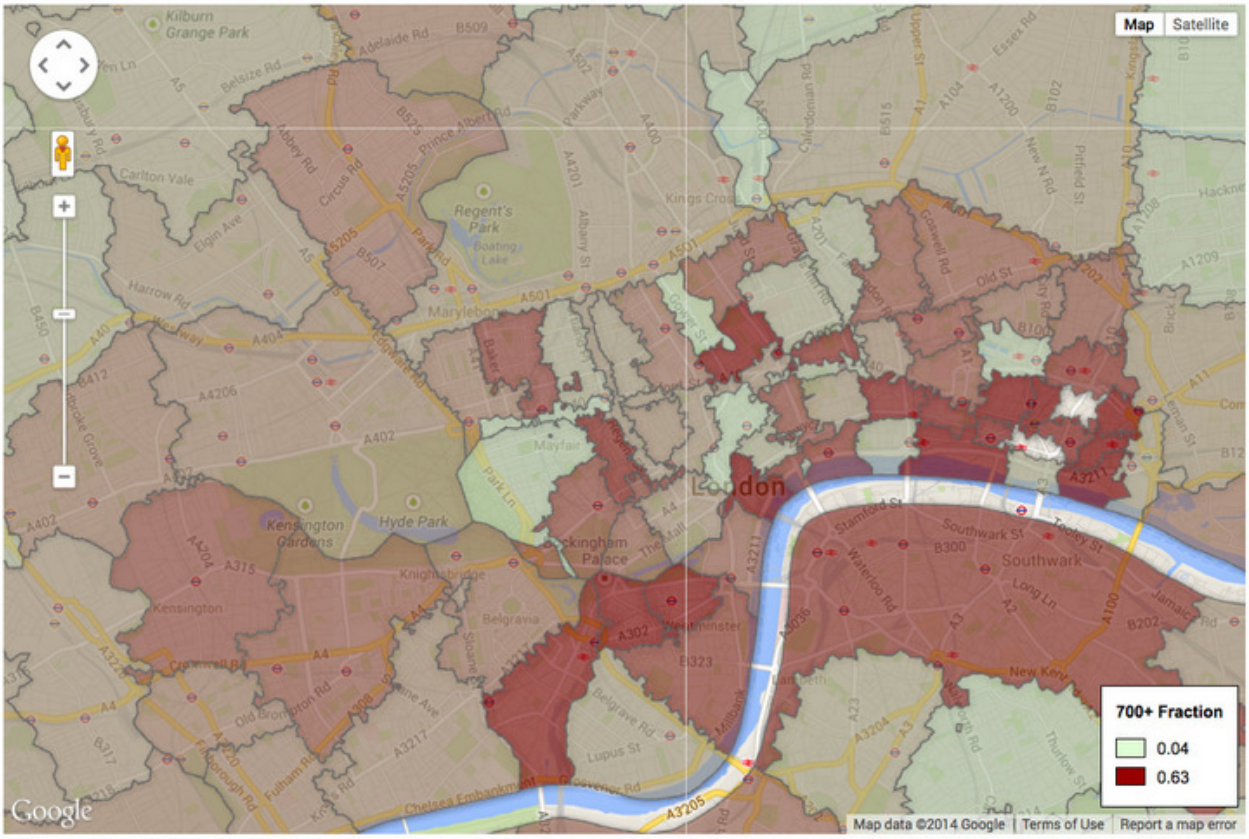
Note: Figure shows the fraction of flat transactions with 150-300 years remaining in each UK 3-digit postcode. Green and red correspond to the 10th and 90th percentile of the distribution of the fraction across postcodes. The figure zooms in on London.

Figure A.13: U.K. Flats: Fraction of 700+ years leaseholds



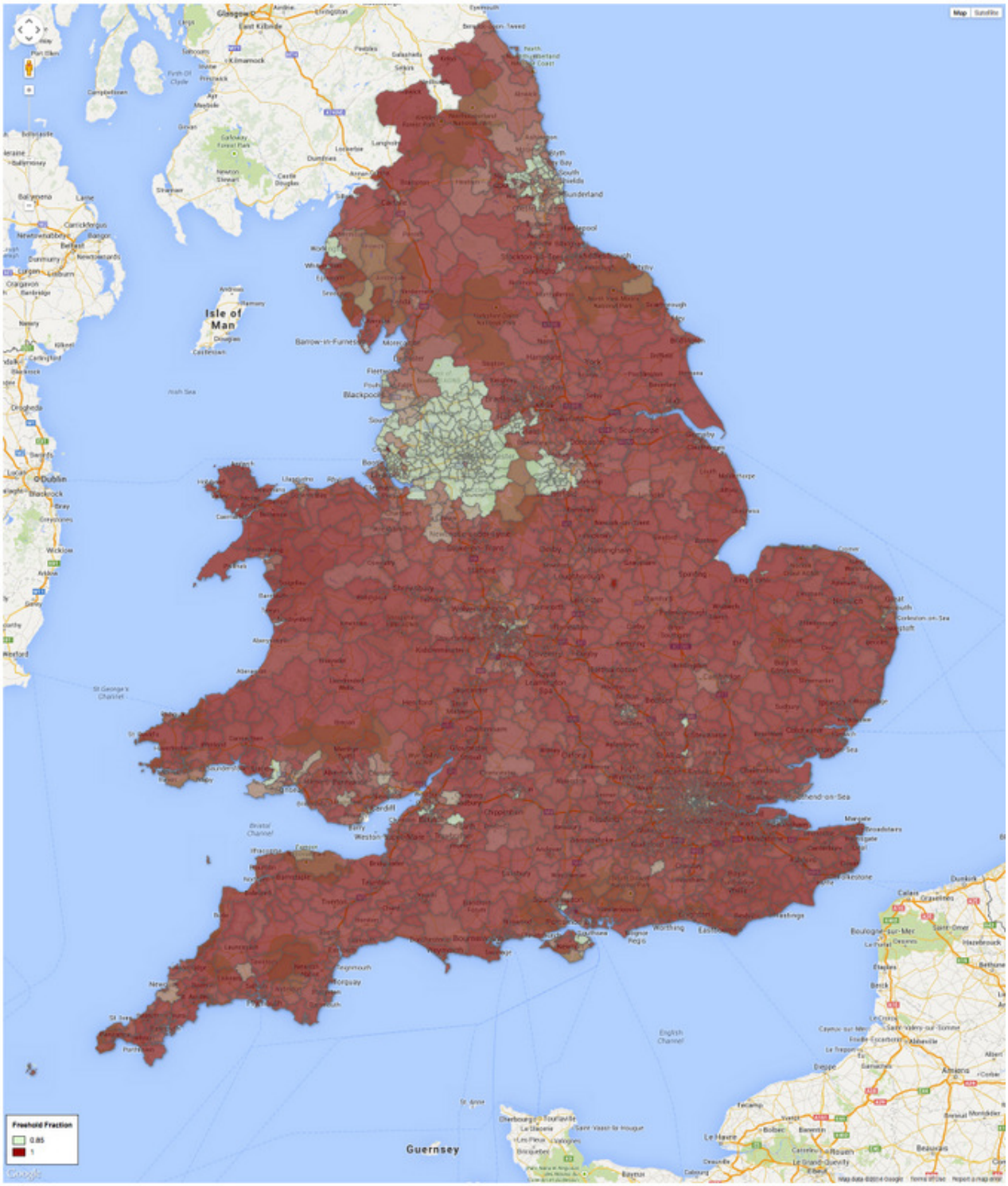
Note: Figure shows the fraction of flat transactions with 700+ years remaining in each UK 3-digit postcode. Green and red correspond to the 10th and 90th percentile of the distribution of the fraction across postcodes.

Figure A.14: London Flats: Fraction of 700+ years leaseholds



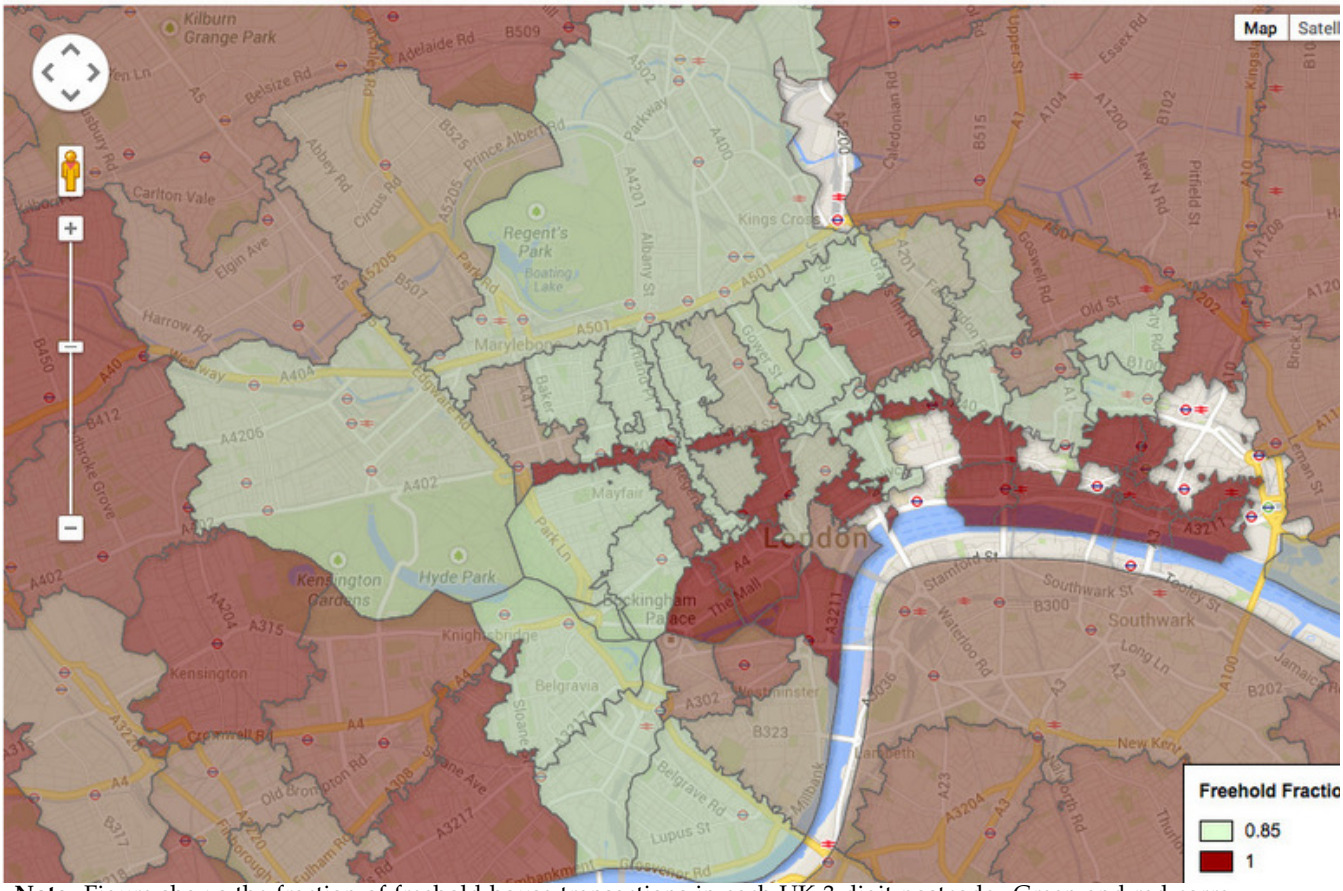
Note: Figure shows the fraction of flat transactions with 700+ years remaining in each UK 3-digit postcode. Green and red correspond to the 10th and 90th percentile of the distribution of the fraction across postcodes. The figure zooms in on London.

Figure A.15: U.K. Houses: Fraction of Freeholds



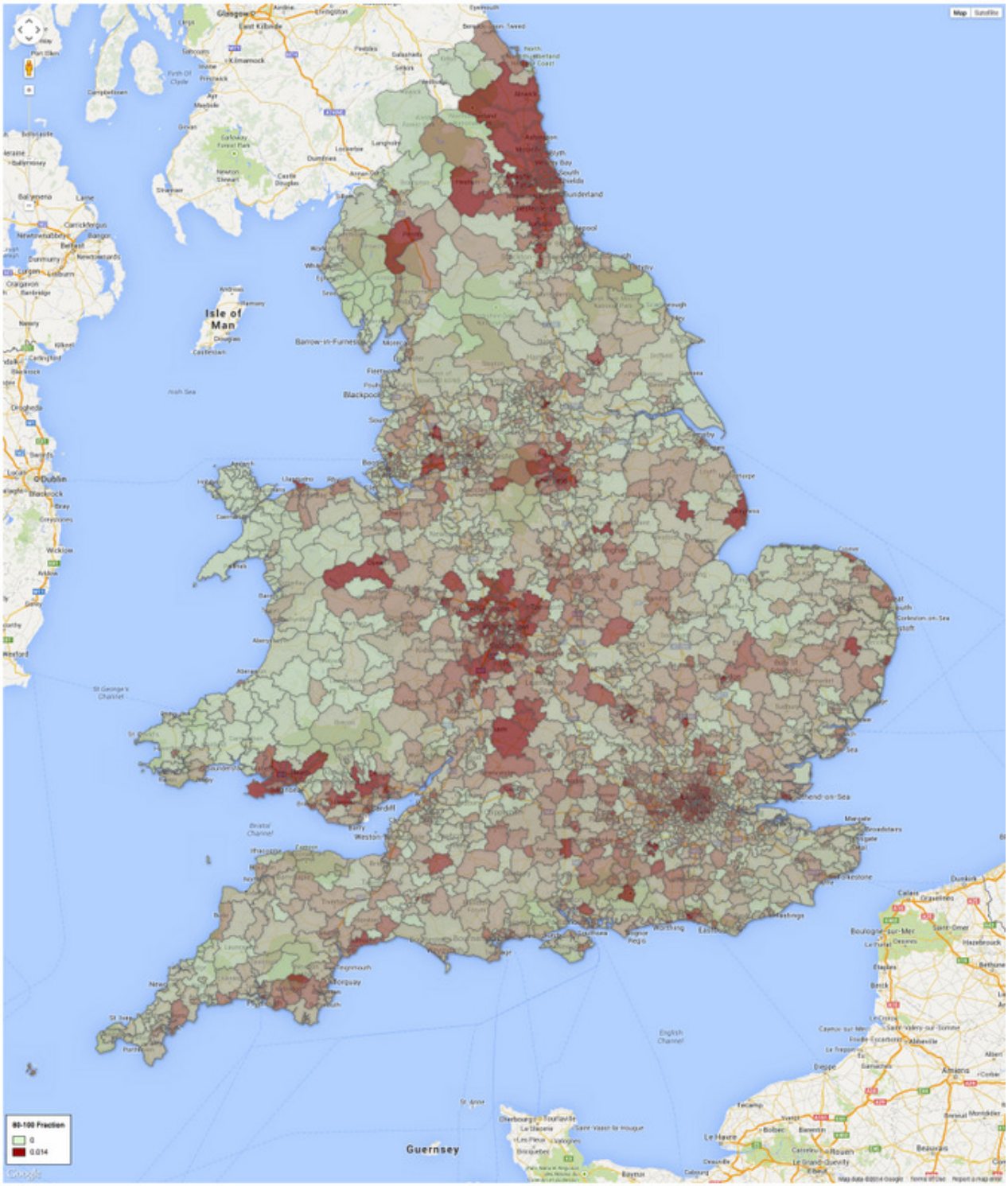
Note: Figure shows the fraction of freehold house transactions in each UK 3-digit postcode. Green and red correspond to the 10th and 90th percentile of the distribution of the fraction across postcodes.

Figure A.16: London Houses: Fraction of Freeholds



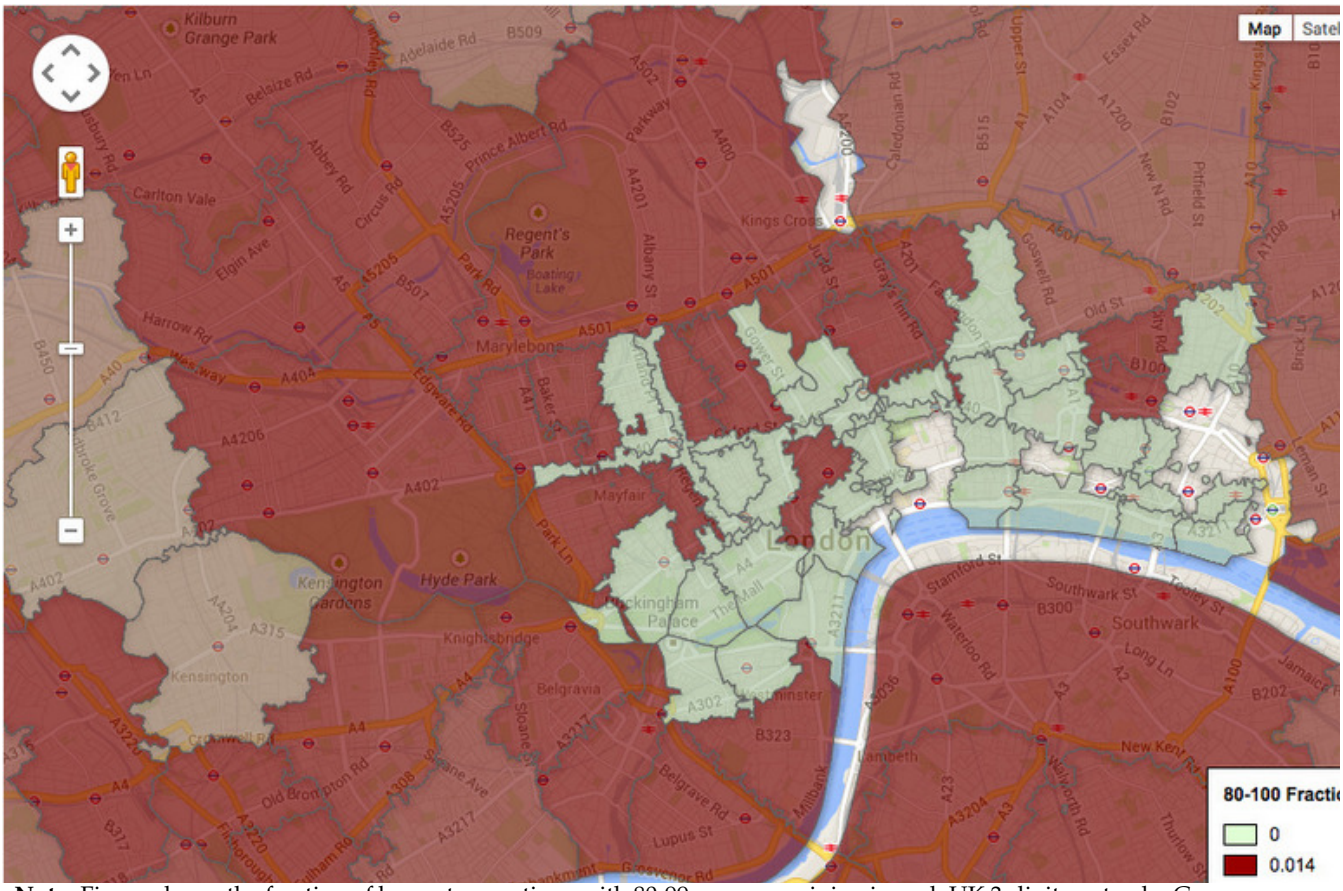
Note: Figure shows the fraction of freehold house transactions in each UK 3-digit postcode. Green and red correspond to the 10th and 90th percentile of the distribution of the fraction across postcodes. The figure zooms in on London.

Figure A.17: U.K. Houses: Fraction of 80-99 years leaseholds



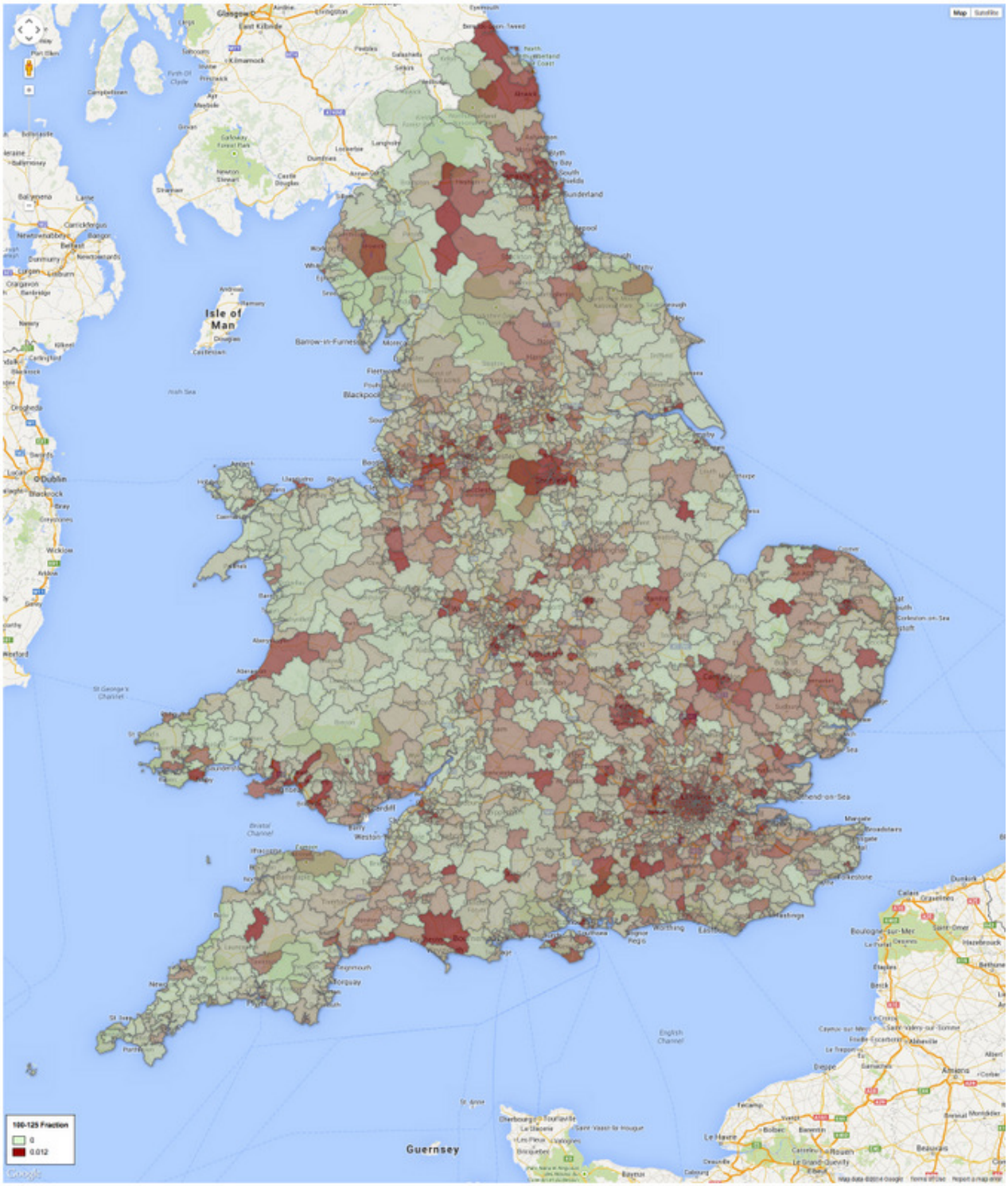
Note: Figure shows the fraction of house transactions with 80-99 years remaining in each UK 3-digit postcode. Green and red correspond to the 10th and 90th percentile of the distribution of the fraction across postcodes.

Figure A.18: London Houses: Fraction of 80-99 years leaseholds



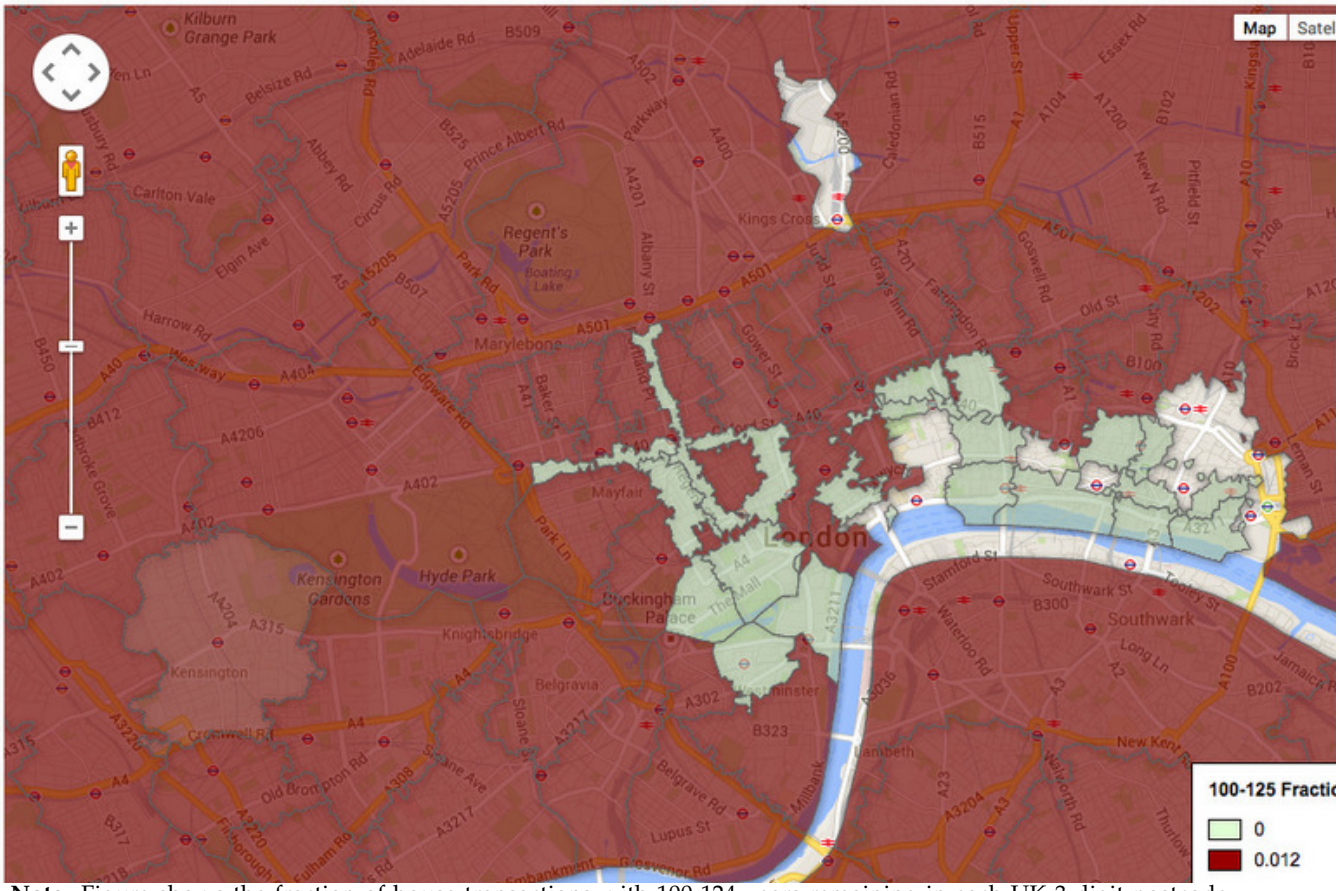
Note: Figure shows the fraction of house transactions with 80-99 years remaining in each UK 3-digit postcode. Green and red correspond to the 10th and 90th percentile of the distribution of the fraction across postcodes. The figure zooms in on London.

Figure A.19: U.K. Houses: Fraction of 100-124 years leaseholds



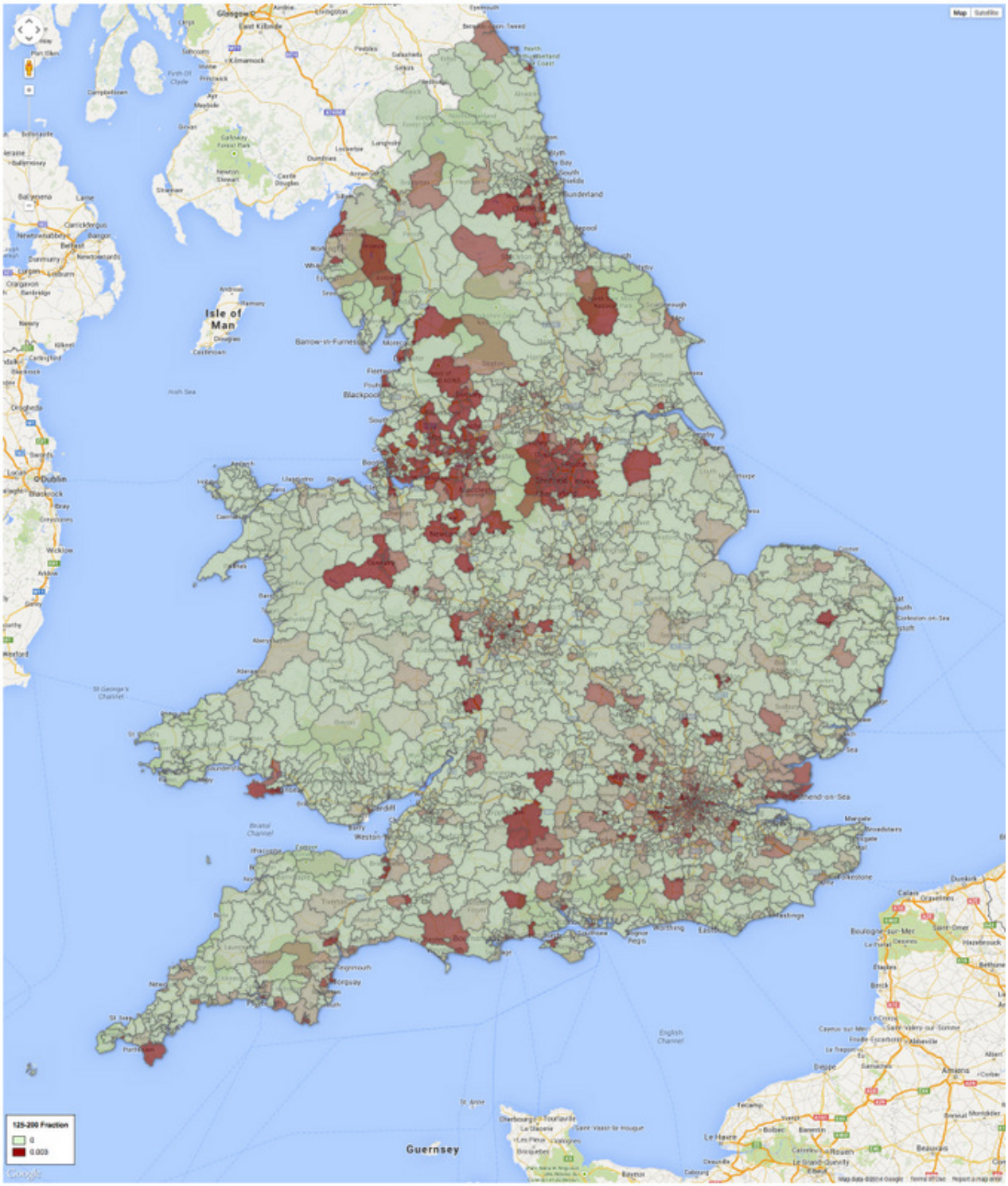
Note: Figure shows the fraction of house transactions with 100-124 years remaining in each UK 3-digit postcode. Green and red correspond to the 10th and 90th percentile of the distribution of the fraction across postcodes.

Figure A.20: London Houses: Fraction of 100-124 years leaseholds



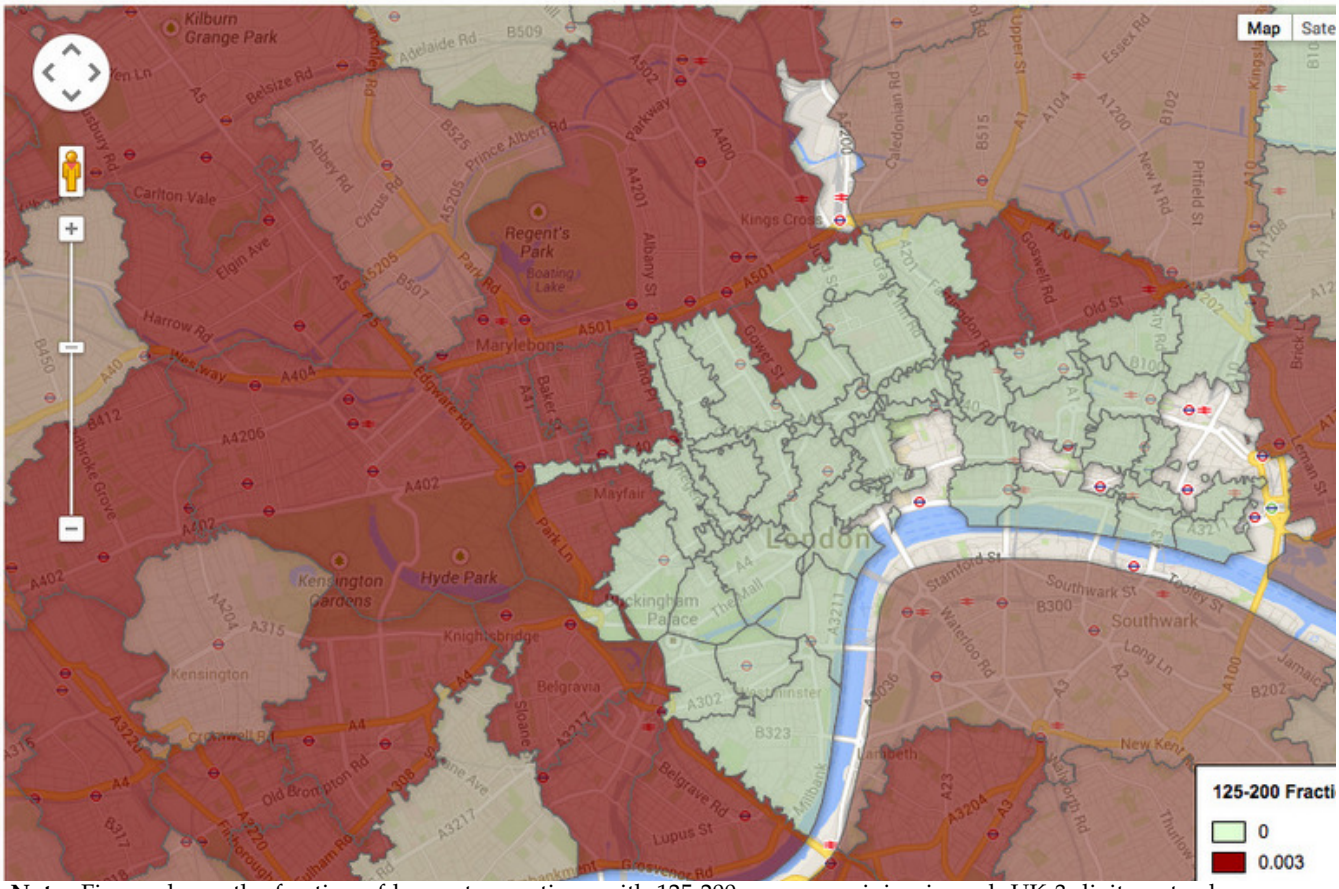
Note: Figure shows the fraction of house transactions with 100-124 years remaining in each UK 3-digit postcode. Green and red correspond to the 10th and 90th percentile of the distribution of the fraction across postcodes. The figure zooms in on London.

Figure A.21: U.K. Houses: Fraction of 125-200 years leaseholds



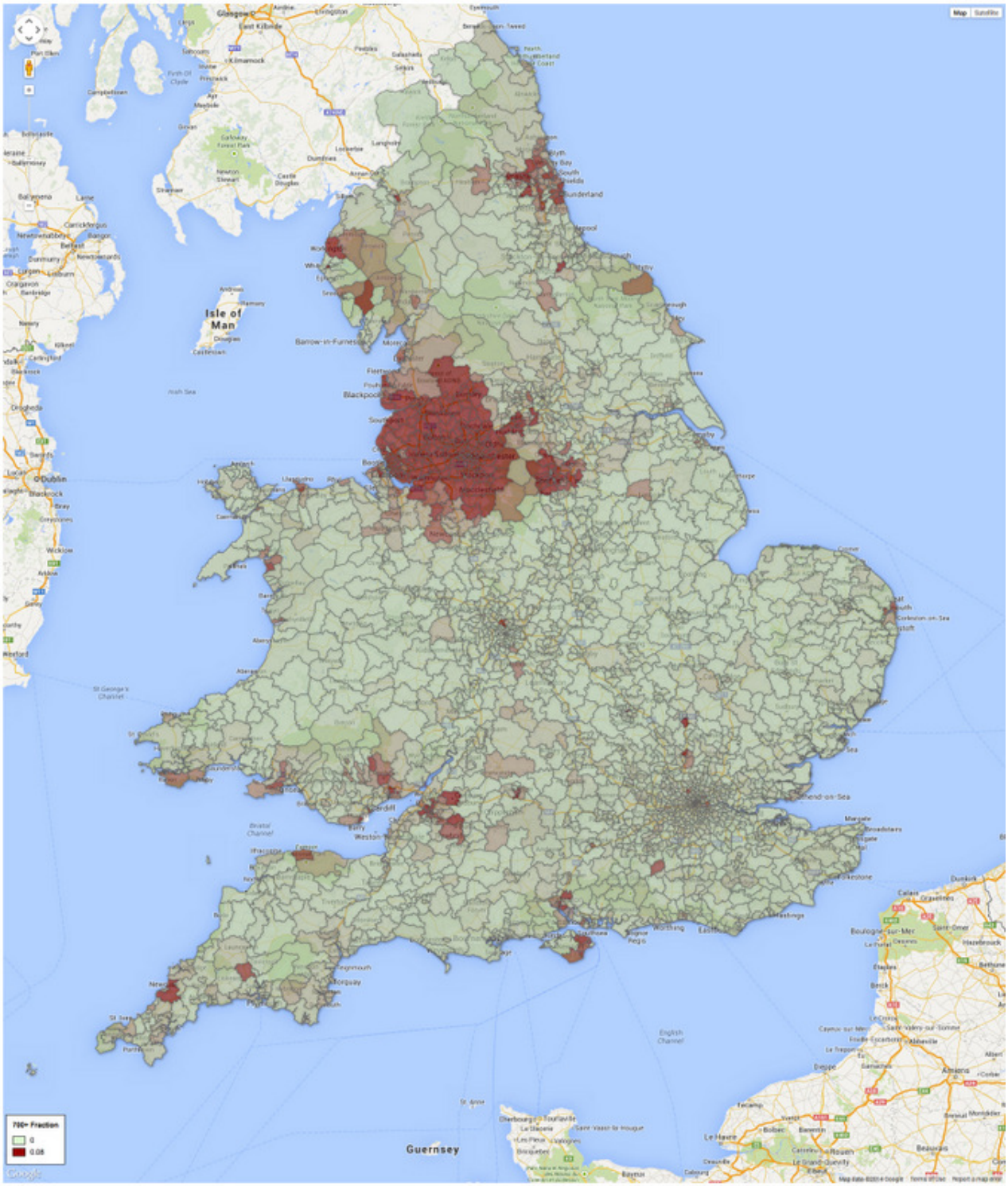
Note: Figure shows the fraction of house transactions with 125-200 years remaining in each UK 3-digit postcode. Green and red correspond to the 10th and 90th percentile of the distribution of the fraction across postcodes.

Figure A.22: London Houses: Fraction of 125-200 years leaseholds



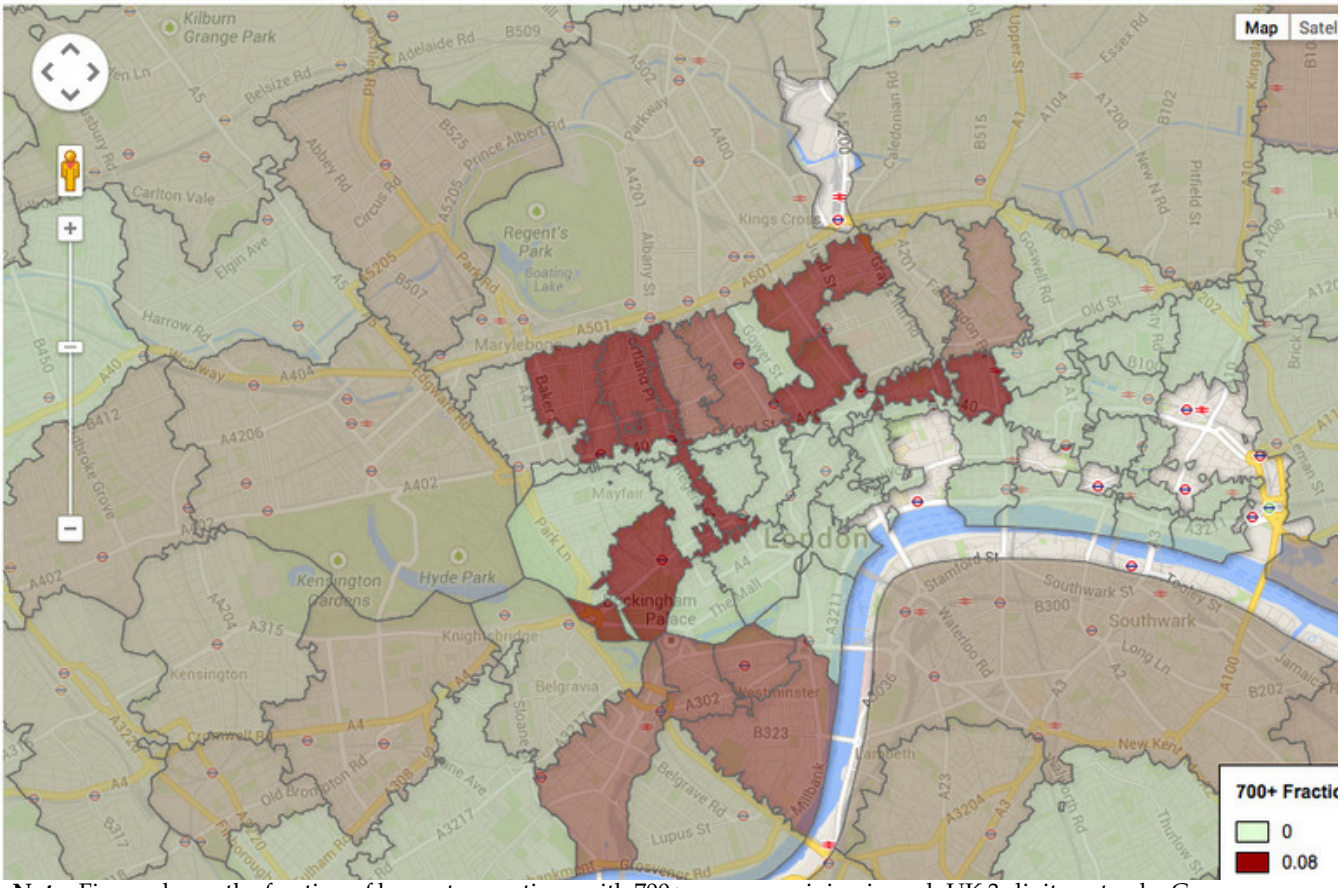
Note: Figure shows the fraction of house transactions with 125-200 years remaining in each UK 3-digit postcode. Green and red correspond to the 10th and 90th percentile of the distribution of the fraction across postcodes. The figure zooms in on London.

Figure A.23: U.K. Houses: Fraction of 700+ years leaseholds



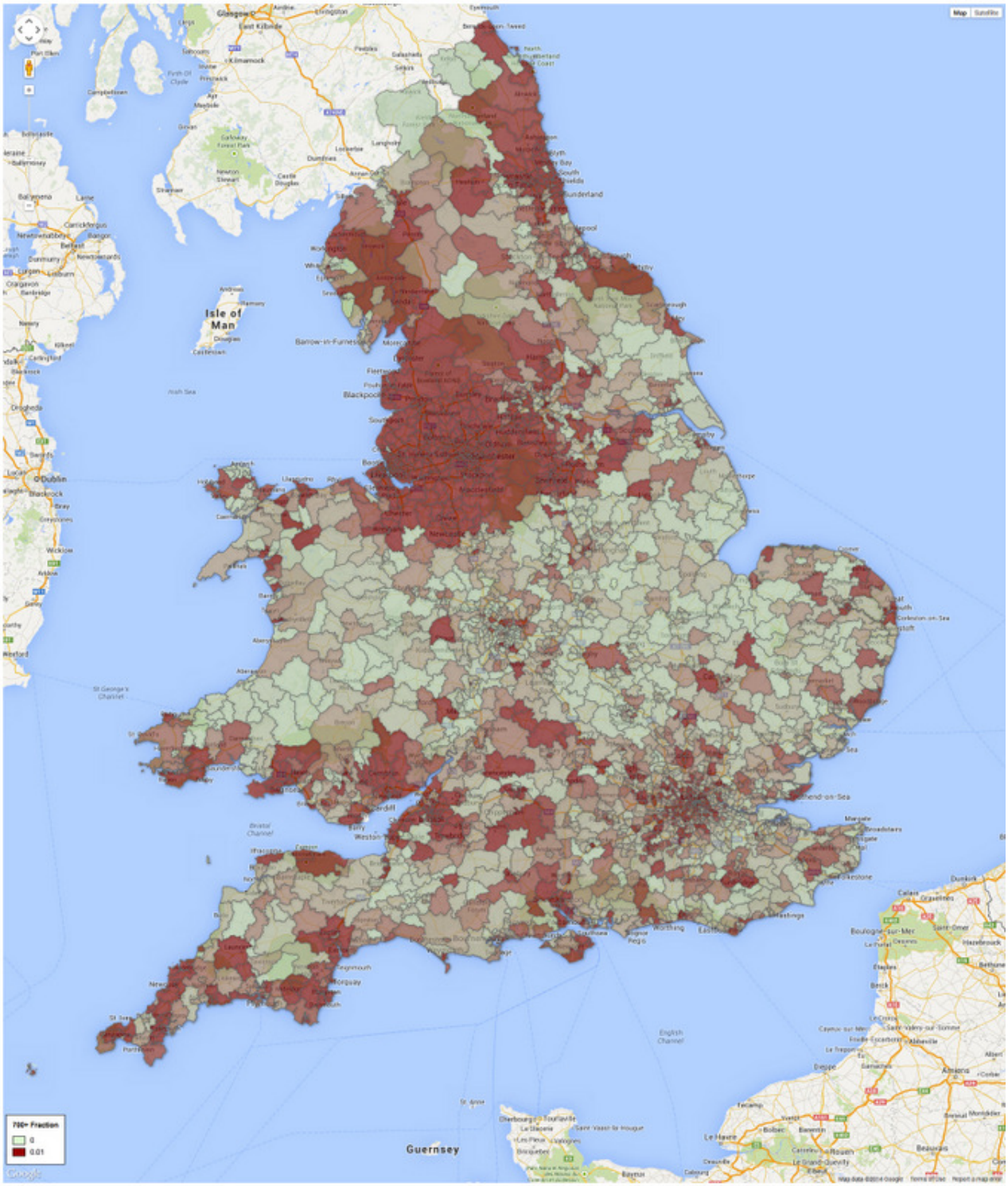
Note: Figure shows the fraction of house transactions with 700+ years remaining in each UK 3-digit postcode. Green and red correspond to the 10th and 90th percentile of the distribution of the fraction across postcodes.

Figure A.24: London Houses: Fraction of 700+ years leaseholds



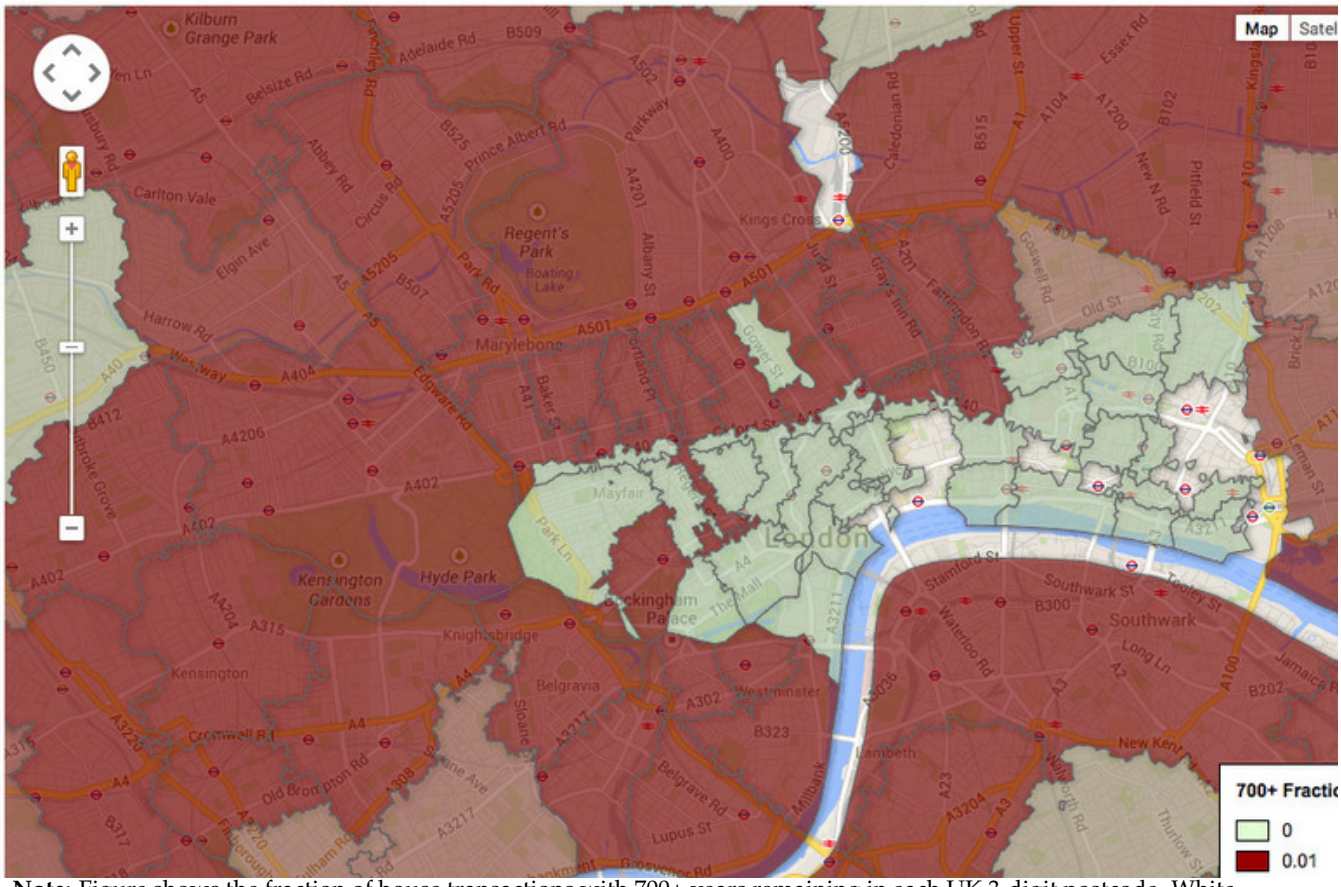
Note: Figure shows the fraction of house transactions with 700+ years remaining in each UK 3-digit postcode. Green and red correspond to the 10th and 90th percentile of the distribution of the fraction across postcodes. The figure zooms in on London.

Figure A.25: U.K. Houses: Fraction of 700+ years leaseholds



Note: Figure shows the fraction of house transactions with 700+ years remaining in each UK 3-digit postcode. White corresponds to the 10th percentile of the distribution of the fraction across postcodes, while black corresponds to 1%

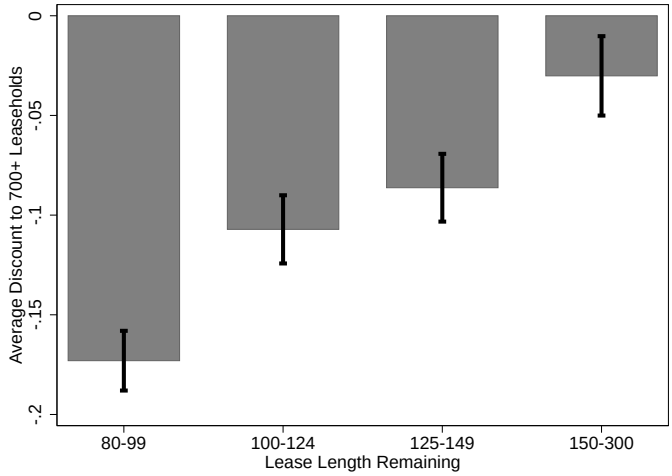
Figure A.26: London Houses: Fraction of 700+ years leaseholds



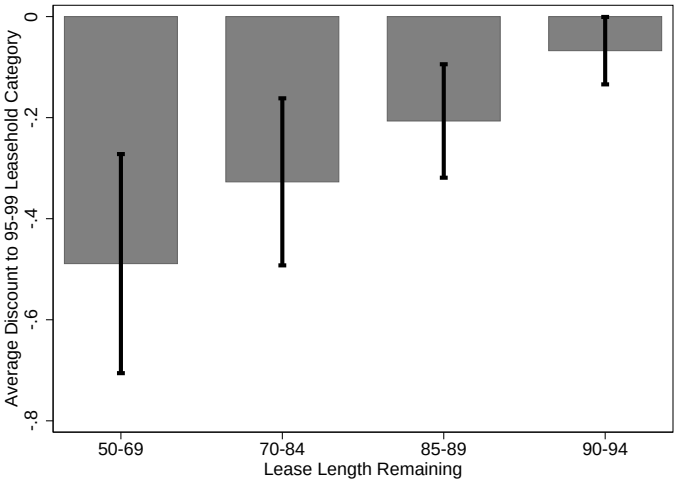
Note: Figure shows the fraction of house transactions with 700+ years remaining in each UK 3-digit postcode. White corresponds to the 10th percentile of the distribution of the fraction across postcodes, while black corresponds to 1%. The figure zooms in on London.

Figure A.27: Price Discount by Remaining Lease Length - Within Leasehold Estimates

(A) U.K. - Relative to Leases with 700+ years remaining

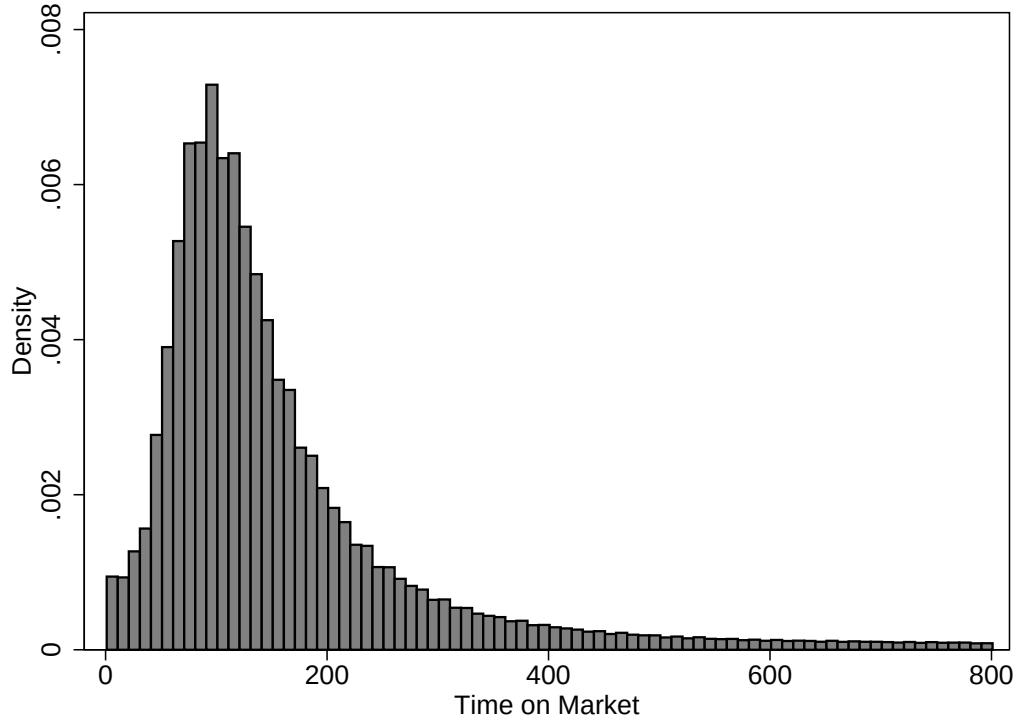


(B) Singapore - Relative to Leases with 95-99 years remaining



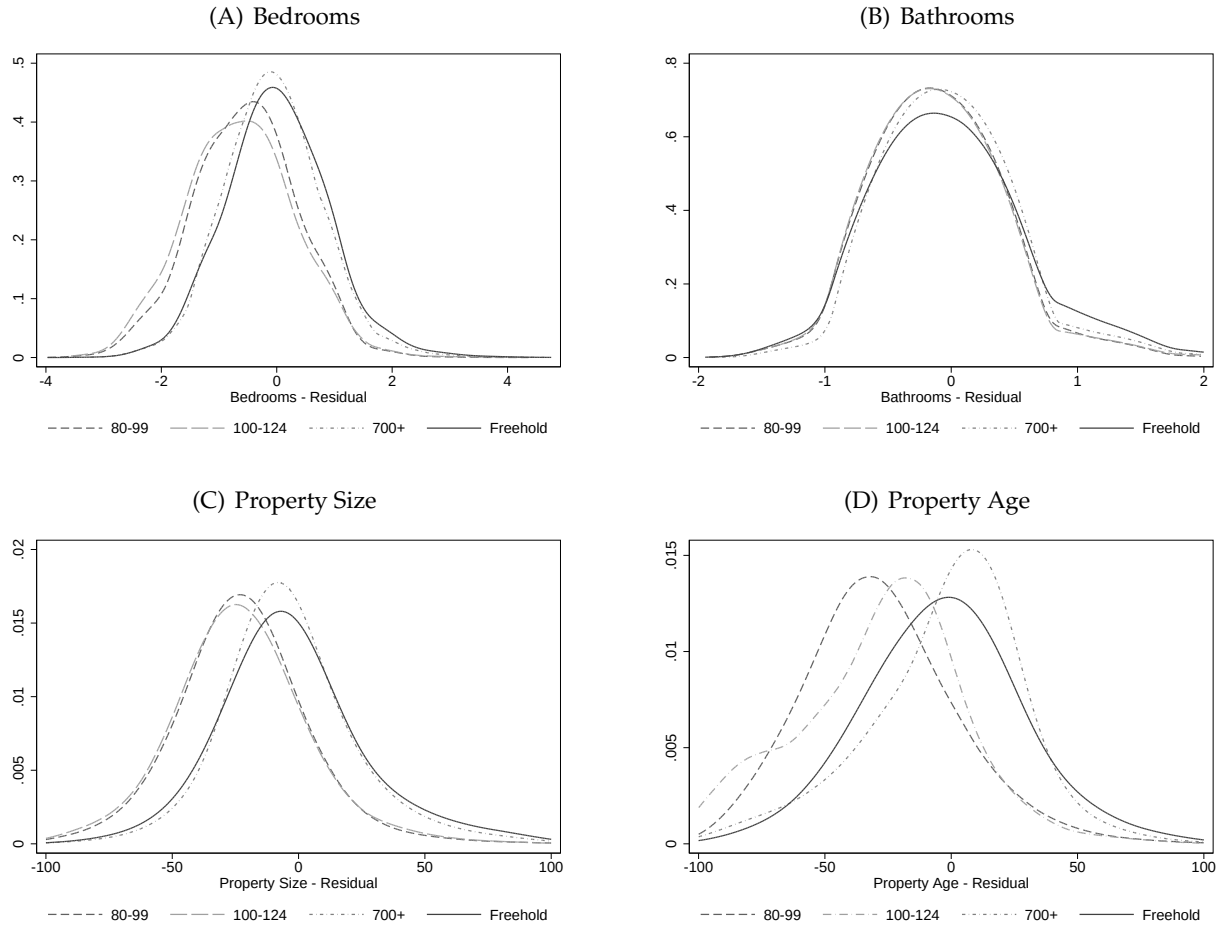
Note: Figure shows β_j coefficients from regression (1) in Panel A and regression (2) in Panel B. In Panel A, which focuses on transactions of U.K. flats, the price discounts are relative to leaseholds with more than 700 years remaining, and correspond to column (1) of Appendix Table A.3. The bars indicate the 95% confidence interval of the estimate using standard errors double clustered by 3-digit postcode and by quarter. Panel B, which focuses on Singapore transactions, corresponds to column (2) in Appendix Table A.4. We restrict to an estimation within strata leases with an initial lease length of 99 years. The excluded category are those leaseholds with 95-99 years remaining. The bars indicate the 95% confidence interval of the estimate using standard errors double clustered by 5-digit postcode and by quarter.

Figure A.28: Distribution of Time on Market



Note: Figure shows the distribution of the time on market observed in our data.

Figure A.29: U.K. Houses: Hedonic Characteristics by Lease Type



Note: Figure shows the distribution of residuals from a regression of property characteristics on 3-digit postcode fixed effects for freeholds and leaseholds with different remaining maturity. The sample is U.K. houses, the characteristics plotted are: number of bedrooms, number of bathrooms, property size (square meters), and property age (years).

APPENDIX TABLES

Table A.1: U.K. Summary Statistics: Share of Leaseholds and Freeholds by Postcode

Houses	Mean	Stdev	p10	p25	p50	p75	p90
Share of							
Freeholds	0.943	0.128	0.857	0.966	0.986	0.993	0.997
80-99	0.008	0.021	0	0.001	0.003	0.007	0.015
100-124	0.008	0.032	0	0.001	0.003	0.006	0.012
125-200	0.003	0.020	0	0	0	0.001	0.003
700+	0.039	0.114	0	0.001	0.004	0.014	0.078

Flats	Mean	Stdedv	p10	p25	p50	p75	p90
Share of							
Freeholds	0.076	0.133	0.009	0.018	0.038	0.076	0.164
80-99	0.177	0.157	0.006	0.052	0.145	0.263	0.388
100-124	0.322	0.191	0.070	0.182	0.322	0.440	0.562
125-149	0.069	0.077	0	0.021	0.051	0.088	0.153
150-300	0.052	0.094	0	0	0.017	0.058	0.138
700+	0.304	0.229	0.042	0.126	0.259	0.443	0.636

Note: Table shows descriptive statistics on the fractions of freeholds and leaseholds of each maturity bucket by 3-digit U.K. postcode.

Table A.2: U.K. Houses: Impact of Lease Type on Prices

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Lease Length Remaining							
80-99 Years	-0.375***	-0.378***	-0.379***	-0.375***	-0.364***	-0.332***	-0.374***
	(0.021)	(0.020)	(0.020)	(0.002)	(0.020)	(0.019)	(0.022)
100-124 Years	-0.296***	-0.298***	-0.298***	-0.297***	-0.286***	-0.273***	-0.290***
	(0.016)	(0.016)	(0.016)	(0.002)	(0.015)	(0.016)	(0.017)
$>$ 700 Years	-0.012**	-0.012**	-0.012**	-0.012**	-0.011*	-0.007	-0.011*
	(0.006)	(0.006)	(0.006)	(0.001)	(0.006)	(0.006)	(0.006)
Fixed Effects	PC × M × House	PC × Q × House	PC × Y × House	PC × M × House	PC × M × House	PC × M × House	PC × M × House
Controls	✓	✓	✓	✓, × year	✓	✓	✓
Restrictions	·	·	·	·	Wisorize Price	Nonmiss. Hedonics	Exclude London
R-squared	0.783	0.781	0.777	0.785	0.790	0.820	0.765
N	6,628,133	6,628,133	6,628,133	6,628,133	6,628,133	5,453,962	6,393,099

Note: Table shows results from regression (1). The dependent variable is log price, for houses sold in England and Wales between 2004 and 2013. We include 3-digit postcode by house type (detached, semi, terraced) by transaction time fixed effects. In columns (2) and (3) the transaction time is the transaction quarter and year, respectively, in the other columns the transaction month. We also control for property size, the number of bedrooms, the number of bathrooms, property age, property condition, whether there is parking, and the type of heating. In column (4) we interact the controls with the transaction year. In column (5) we winsorize the price at the 1st and 99th percentile. In column (6) we only include properties for which characteristics are not missing. In column (7) we exclude transactions in London. Standard errors are double clustered by 3-digit postcode and by quarter. Significance Levels: * ($p<0.10$), ** ($p<0.05$), *** ($p<0.01$).

Table A.3: Impact of Lease Type on Prices - U.K. Flats, relative to 700+ year leaseholds

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Lease Length Remaining							
80-99 Years	-0.173***	-0.173***	-0.174***	-0.172***	-0.165***	-0.144***	-0.170***
	(0.008)	(0.007)	(0.007)	(0.001)	(0.007)	(0.008)	(0.008)
100-124 Years	-0.107***	-0.104***	-0.101***	-0.105***	-0.100***	-0.099***	-0.069***
	(0.009)	(0.008)	(0.007)	(0.001)	(0.008)	(0.009)	(0.006)
125-149 Years	-0.086***	-0.084***	-0.081***	-0.085***	-0.078***	-0.074***	-0.056***
	(0.009)	(0.008)	(0.008)	(0.001)	(0.008)	(0.008)	(0.008)
150-300 Years	-0.030**	-0.031***	-0.030**	-0.029***	-0.024*	-0.015	-0.008
	(0.010)	(0.009)	(0.009)	(0.001)	(0.010)	(0.009)	(0.010)
Fixed Effects	PC × M	PC × Q	PC × Y	PC × M	PC × M	PC × M	PC × M
Controls	✓	✓	✓	✓, × year	✓	✓	✓
Restrictions	.	.	.	.	Wisorize Price	Nonmiss. Hedonics	Exclude London
R-squared	0.732	0.724	0.714	0.733	0.740	0.778	0.620
N	1,338,244	1,338,244	1,338,244	1,338,244	1,338,244	931,198	996,907

Note: Table shows results from regression (1), excluding freeholds and computing the discounts relative to the 700+ year leaseholds. The dependent variable is log price, for flats sold in England and Wales between 2004 and 2013. We include 3-digit postcode by transaction time fixed effects. In columns (2) and (3) the transaction time is the transaction quarter and year, respectively, in the other columns the transaction month. We also control for property size, the number of bedrooms, the number of bathrooms, property age, property condition, whether there is parking, and the type of heating. In column (4) we interact the controls with the transaction year. In column (5) we winsorize the price at the 1st and 99th percentile .In column (6) we only include properties for which characteristics are not missing. In column (7) we exclude transactions in London. Standard errors are double clustered by 3-digit postcode and by quarter. Significance Levels: * ($p<0.10$), ** ($p<0.05$), *** ($p<0.01$).

Table A.4: Impact of Lease Type on Prices - Singapore, Relative to 96-99 Year Lease

	Relative to 96-99 Year Leases			
	(1)	(2)	(3)	(4)
Lease Length Remaining				
50-69 Years	-0.376***	-0.469***	-0.489***	-0.599***
	(0.111)	(0.104)	(0.111)	(0.164)
70-84 Years	-0.348***	-0.358***	-0.327***	-0.325***
	(0.077)	(0.084)	(0.084)	(0.094)
85-89 Years	-0.221***	-0.223***	-0.207***	-0.196***
	(0.051)	(0.051)	(0.057)	(0.057)
90-94 Years	-0.058	-0.072**	-0.067**	-0.056
	(0.038)	(0.030)	(0.034)	(0.044)
Fixed Effects	PC × Y × Prop Type × Title Type	PC × Q × Prop Type × Title Type	PC × M × Prop Type × Title Type	PC × M × Prop Type × Title Type
Controls	✓	✓	✓	✓
Restrictions	.	.	.	New Only
R-squared	0.955	0.967	0.970	0.969
N	172,690	172,690	172,690	82,408

Note: Table shows results from regression (2). The dependent variable is log price, for strata properties with initially 99-year leases sold by private parties in Singapore between 1995 and 2013. The excluded category is transactions for leaseholds with 95-99 years remaining. We include 5-digit postcode by property type (apartment, condominium, detached house, executive condominium, semi-detached house and terrace house) by title type (strata or land) by transaction date fixed effects. In column (1), the transaction date interaction is for the transaction year, in column (2) the transaction quarter, and in columns (3) and (4) the transaction month. We also control property age, property size, and the total number of units in the property. In column (4) we only focus on properties that were built within the last 3 years of the transaction date. Standard errors are double clustered by 5-digit postcode and by quarter. Significance Levels: * ($p<0.10$), ** ($p<0.05$), *** ($p<0.01$).