

SUPPLEMENT TO “NO-BUBBLE CONDITION: MODEL-FREE TESTS
IN HOUSING MARKETS”: ONLINE APPENDIX
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IN THIS SUPPLEMENTAL APPENDIX, we provide additional information and results. Appendix A.1 provides more details on the data sources used in this paper. Appendix A.2 reviews and implements existing time-series tests for classic rational bubbles. Appendix A.3 reviews the institutional framework that regulates the relationship between leaseholders and freeholders in the U.K., focusing on characteristics that might affect the relative value of extremely-long leaseholds (with maturities of 700 years or more). Finally, Appendix A.4 expands on some of the theoretical derivations in the paper.

A.1. DATA APPENDIX

This appendix reports details on the sources and construction of data series used throughout the paper. These data are not the main data set of leasehold and freehold transactions and property characteristics, which is described in detail in the main text and in [Giglio, Maggiori, and Stroebel \(2015\)](#), but ancillary data such as the series used to build Figure 1, or the analysis of foreign inflows of money in the U.K. property market referenced in Section 2.4.

A.1.1. Construction of Figure 1

We first describe the sources and construction of the series plotted in Figure 1.

U.K. Real House Price Indices: The real house price index for the U.K. is constructed by combining the Nationwide House Price Index (a nominal series) and the U.K. Office of National Statistics (ONS) “long-term indicator of prices of consumer goods and services” (code: CDKO). The CDKO series is the standard measure for historical inflation in the U.K., since the CPI was adopted later than in other countries. The value for the house price index for 2005 was missing in the Nationwide data. We impute it by applying the 2005 growth rate from the Land Registry data for the same year. The price index for London is obtained from the Land Registry. The price index for Prime Central London (PCL) is obtained from the coefficients on the year fixed effects in a hedonic regression with prices as the dependent variable that includes the same controls of our main specification, restricted to PCL only. Both geographically focused time series are also deflated using the CDKO series.

Singapore Real House Price Index: The nominal annual house price index is from the Urban Redevelopment Authority (series: Price Index, Whole Island).

Website: <https://spring.ura.gov.sg/lad/ore/login/index.cfm>). The CPI is from Statistics Singapore (series: M211702.1 P219905). We obtain the real house price index by deflating the nominal index by the CPI.

U.K. Real Rent Index: The real rent index for the U.K. is constructed by dividing the “actual rents for housing” series from the ONS (code: D7CE) by the ONS’s “long term indicator of prices of consumer goods and services” (code: CDKO).

Singapore Real Rent Index: The nominal rent index is from the Urban Redevelopment Authority (series: Rent Index, Whole Island. Website: <https://spring.ura.gov.sg/lad/ore/login/index.cfm>). The CPI is from Statistics Singapore (series: M211702.1 P219905). We obtain the real rent index by deflating the nominal index by the CPI.

U.K. Median Income: The time series for the median income per household, measured in current £ per year, is obtained from the ONS publication “The Effects of Taxes and Benefits on Household Income,” Table 14: “Average incomes, taxes and benefits by decile groups of ALL households.”

GDP Per Capita (U.K. and Singapore): The time series of GDP per capita are obtained from the World Bank Open Dataset, using the *Stata* software *wbopendata*. We use the code NY.GDP.PCAP.CN, for the country codes GBR (for the U.K.) and SGP (for Singapore). The series are in current values of the local currency.

Private Final Consumption Expenditures Per Capita (U.K. and Singapore): The time series of private final consumption expenditures per capita are obtained from the World Bank Open Dataset, using the *Stata* software *wbopendata*. We use the code NE.CON.PRVT.PC.KD, for the country codes GBR (for the U.K.) and SGP (for Singapore). The series are in 2005 US\$.

Bubble Index: For the U.K., the “bubble index” counts the number of times the phrases “real estate bubble” or “housing bubble” and one of “U.K.,” “UK,” “United Kingdom,” or “England” jointly appear in one of the following newspapers: The Sun, The Daily Mail, The Daily Telegraph, The Times, The Sunday Times, The Guardian, The Financial Times, The Independent, The Observer, The Daily Mirror, and The Sunday Mirror, as reported by ProQuest. For Singapore, the “bubble index” counts the number of times the phrases “real estate bubble” or “housing bubble” and “Singapore” jointly appear in all English-language newspapers and periodicals reported by ProQuest. In both countries, the “bubble index” can only be constructed from the year 2000 onwards.

A.1.2. Data Sources for Cross-Sectional Analysis

In Sections 2 and 3, we test for cross-sectional heterogeneity in the price difference between extremely-long leaseholds and freeholds along a number of key dimensions; such analysis helped us, for example, to confirm that there was no classic rational bubble across areas with differential redevelopment potential. In this appendix, we describe the data sources for constructing our measures of cross-sectional heterogeneity.

Price-Income Ratio: In order to construct the price-income ratio, we require information on disaggregated measures of income. In particular, we use the series “Income: Model-Based Estimates at MSOA level” produced by the Regional and Neighborhood Outputs and Analysis Division (RNOAD) of the Office of National Statistics (ONS). These data series are available at the Middle Layer Super Output Areas (MSOA) level. The minimum population in an MSOA is 5,000, and the mean is 7,200. These income estimates are available for the years 2004 and 2007.

We combine these data on average incomes with information on the median transaction price at the MSOA-level, a data series produced by the Public Policy Division of the ONS by analyzing raw transaction data from the Land Registry. All data are obtained through the Neighborhood Statistics portal of the ONS. All data series are accessible at: <https://neighbourhood.statistics.gov.uk/dissemination/>.

Housing Stock Growth: To construct the growth of the housing stock, we use data from the 2001 and 2011 U.K. censuses. The data series for the number of dwellings is UV55 in the 2001 census, and QS418EW in the 2011 census. The housing stock is computed at the Lower Layer Super Output Area (LSOA) level. There are 34,378 unique LSOAs, with between 400 and 1,200 households.

Other Cross-Sectional Variation: We also consider cross-sectional variation in the relative pricing of leaseholds and freeholds along a number of other dimensions, including the average time on market, the share of transactions that are for flats, and the share of transactions that are for new properties. These measures of market activity are constructed within the transaction data set described in the main text.

A.1.3. U.K. Rent Data

Rental listing data for the U.K. were obtained by systematically downloading all rental listings that were live on March 30, 2015, on the two online listing portals rightmove.co.uk and zoopla.co.uk. From these rental listings, we extract information on the number of bedrooms, the number of bathrooms, and whether the property is furnished or unfurnished. These are used as controls in our hedonic regression analysis. Since rental listings do not contain information on the precise location of the property, we had to extract property location by reverse-geocoding the location of a marker placed by the portals on Google Maps. This marker is placed at the center of the property’s complete postcode. While this does not reveal the precise location of the property, U.K. postcodes are extremely small geographic areas: the median (mean) postcode has 14 (18) households. This means that the overwhelming majority of postcodes only contains properties that are trading on the same contract structure (i.e., freehold or extremely-long leasehold). For all postcodes for which we can verify from the Land Registry data that they only contain properties of one contract type, we assign that contract type to all rental listings located in that postcode. Since

we cannot precisely match each rental listing to the property information in our baseline data, we do not control for hedonic characteristics beyond those contained in the rental listing. However, all of our findings are confirmed if we assign each property the average characteristics of properties in that postcode (as discussed above, there are only a few relatively homogeneous properties in each postcode).

A.1.4. *Foreign Buyers*

In Section 2.4, we perform our test for classic rational bubbles on two subsamples of the data: London and Prime Central London (PCL). As highlighted in the main text, PCL is an area of particular interest for our test since it exhibits many features that are commonly associated with housing bubbles. Here we provide details on one of these dimensions, the share of homes purchased by foreign buyers.

London is a socially and ethnically diverse city. [Savills \(2012\)](#) reported that 35% of the residents of Greater London were born outside the U.K., and that a large number of properties each year are bought by foreign nationals that are U.K. residents. A more striking pattern, however, is the strong increase in purchases of London properties by foreign nationals who are not U.K. residents. This pattern, which is highly concentrated in the high-end market of PCL, has led to a number of complaints that it induces abnormal house price growth in these areas, that it reduces housing affordability for current residents, and that it creates house price bubbles and financial instability. These complaints are exemplified by the newspaper articles or think-tank reports below:

- [The Guardian](#), June 20, 2013 (accessed on April 19, 2015): “Prime central London property prices inflate bubble fears”:

Land Registry figures show the most expensive areas of the country—and those that have seen some of the biggest increases in prices—are the neighbourhoods that estate agents like to call “prime central London.” [...] It may seem that the only way is up, but politicians, retailers and even estate agents are warning that expensive homes are creating soaring rents, an exodus of small shops and a ghost town atmosphere, and that the market could turn out to be a bubble. [...] One big concern about the PCL boom is that it is leading to streets where nobody actually lives. “More and more stats and anecdotes indicate that ‘Fortress Central London’ is emptying of residents,” says Ed Mead of Douglas & Gordon, an estate agency with 11 branches across the capital. He says many overseas buyers own multiple homes around the world and rarely spend time in any one, however much it cost. As a result, parts of PCL fail the neighbourhood test of having milk and newspapers on sale within a short walk of where people live. “Why should owners care? They’re never here to need them,” Mead says.

- [The Daily Mail](#), August 8, 2013 (accessed on April 19, 2015): “Wealthy foreign buyers boost London property bubble which ‘could burst’ (and one in 10 mortgages are now buy-to-let)”:

Demand from wealthy overseas buyers for multi-million pound London homes is fuelling a property bubble in the capital, experts say. [...] ‘That just cannot carry on,’ buying agent

Henry Pryor told the Guardian, adding that the capital was ‘in a bubble.’ [...] Meanwhile the number of properties in London’s most desirable postcodes being snapped up by foreign buyers has sparked fears UK buyers are being priced out of the market.

- The *Civitas* think-tank report by David and Bentley (2014):

Estimates vary, but billions of pounds of overseas money are pouring into the London residential property market every year. The totals have been rising in recent years, most notably at the top end of the market. When it comes to prime central London property, Savills says £7 billion of international money was spent on high-end London homes last year, with only 20% of prime property purchases being from the UK. Most importantly, two-thirds were investors rather than owner-occupiers. London Property Partners found up to 85% of prime London property purchases in 2012 were made with overseas money. Just 15% were by UK buyers. [...] The UK property market is being used as an investment vehicle by the global super-rich and increasingly the simply well-to-do. The inflationary impact of this extra cash is good news for property owners (until they want to trade up the housing ladder). It is good news for estate agents on commission, who report with glee every pulse and surge in the market. But it is not good for those already being priced out at the bottom.

Allegedly, foreign residents are buying these properties as trophies (e.g., they tend not to rent them out), to evade their home country capital controls/taxes, and as a store of value. Asset markets that attract significant capital flows from investors looking for a store of value are more likely to exhibit features of a bubble. For example, bubbles in Farhi and Tirole (2012) arise because of a shortage of assets that can act as a store of value (i.e., safe assets and assets with high pledgeability). Of course, at the same time, there are fundamental reasons for the strong house price growth in these areas, such as a shortage in land that can be developed for housing, and restrictions on redevelopment of PCL historic listed buildings.

Many real estate agents report the share of their sales that have a foreign buyer. For example, Savills (2012) reported that foreign buyers accounted for 59% of all PCL sales in 2011–2012, up from 46% in 2007.¹ They noted, however, that an estimated 66% of these foreign nationals are U.K. residents. Strutt & Parker’s (2012) provided similar numbers, reporting that in the six months up to January 2012, 60% of all their sales in PCL featured a foreign buyer.

In Section 2.4, we identified two areas of particular interest for our test, London and PCL, not only based on the broader picture of the market provided above, but (mostly) based on the quantitative analysis in Knight Frank (2013). Knight Frank scanned 3,500 Land Registry titles for newly built properties in the boroughs of London, including the PCL boroughs, with sales prices ranging from £200,000 to £5,000,000. The study analyzed the number of foreign-resident buyers, based on the address of the buyer reported on the Land Registry title. Many properties, particularly in the high-end market, are bought via holding companies or trusts rather than by individuals. In this case, the

¹For London as a whole, they reported 34% of foreign buyers in 2011–2012 and 24% in 2011.

sales were classified as international, with the exception of registered social landlords, or other obviously U.K.-based entities. While this assumption might lead to overestimating the share of foreign buyers, since some U.K. residents might also set up foreign holding companies for their property transactions, it is supported by a number of publications confirming that such non-standard ownership structures are predominantly used by foreigners.² In the two years ending June 2013, 69% of newly built PCL properties were bought by foreign nationals, while 49% of the sales involved foreign residents. The share of buyers who are foreign residents falls from the 49% of PCL to 20% when looking at all London boroughs.³ This markedly different market share of foreigners was (part of) the motivation for showing our results separately for London and PCL, to verify the absence of a classic rational bubble even in those markets that attracted large-scale inflows of foreign capital.

A.1.5. Additional Figures

We also provide additional Figures to support our conclusions in the main body of the text. Figures A.1 and A.2 show the distribution of 700+ year leaseholds in the entire U.K. and in Greater London, respectively. Figures A.3 and A.4 show the distribution of hedonic characteristics after taking out geographic and property type fixed effects for the U.K. and Singapore, respectively. The construction of these figures is discussed in footnotes 16 and 17 in the main body of the paper. Figures A.5 and A.6 show coefficients on the main hedonic controls in the baseline regressions for the U.K. and for Singapore, respectively. These regressions are described in Section 2.3 in the main body of the paper. Figure A.7 shows the distribution of price differences between extremely-long leaseholds and freeholds across the 217 postcode area-years in which we observe at least 1,000 transactions, and in which at least 10% of the transactions were for extremely-long leaseholds and 10% of transactions were for freeholds. This test is described in footnote 23 in the main body of the text.

A.2. EXISTING TIME-SERIES TESTS OF RATIONAL BUBBLES

The empirical literature that formally tests for asset bubbles is vast but, despite the notable research effort, also largely inconclusive. In their recent survey of the literature on bubbles, Brunnermeier and Oehmke (2013) concluded that “*identifying bubbles in the data is a challenging task. The reason is that in*

²See, for example, the report by ICIJ and the Guardian on BVI-based purchases of U.K. property available at: <http://www.icij.org/offshore/secret-london-real-estate-speculators> (accessed April 19, 2015).

³The definition of London used in our paper, for example in Table III, corresponds to the boroughs included in Inner London by Knight Frank (2013).

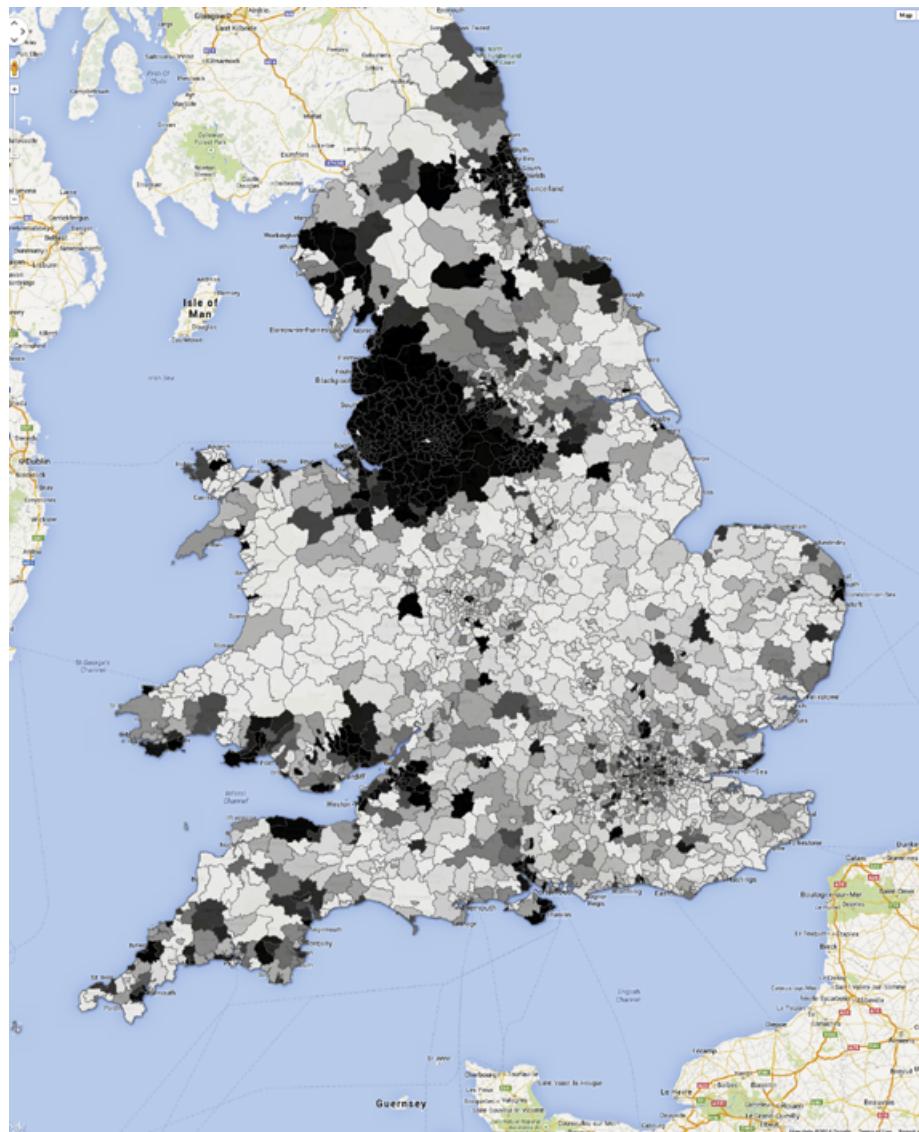


FIGURE A.1.—U.K. sample—distribution of 700+ year leaseholds. *Note:* The map shows the fraction of transactions of leaseholds with more than 700 years remaining for each 3-digit U.K. postcode. White indicates that the fraction was 0%. Black indicates that 2% or more of the transactions were of extremely-long leaseholds, with scales of gray indicating intermediate percentages.

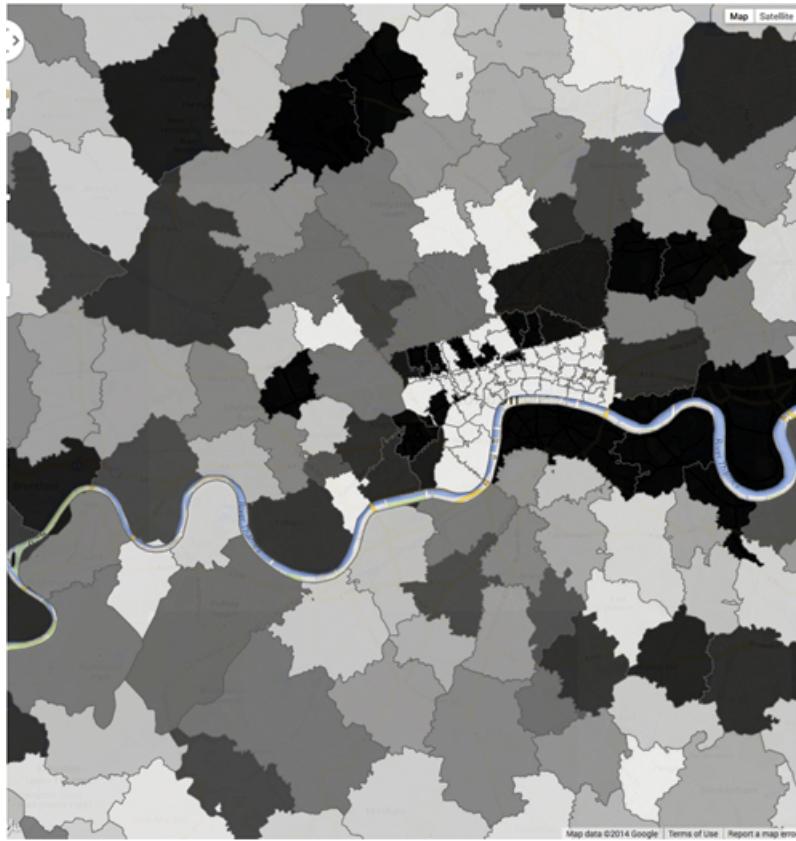


FIGURE A.2.—U.K. sample—distribution of 700+ year leaseholds—London. *Note:* The map shows the fraction of transactions of leaseholds with more than 700 years remaining for each 3-digit U.K. postcode. White indicates that the fraction was 0%. Black indicates that 2% or more of the transactions were of extremely-long leaseholds, with scales of gray indicating intermediate percentages. The figure zooms in on London.

order to identify a bubble, one needs to know an asset's fundamental value, which is usually difficult to measure.”

The previous literature testing for bubbles with failures of the transversality condition faces a number of econometric and interpretational issues. Rather than reviewing each paper in detail, we highlight the main difference between our approach and that of the previous literature.⁴ Previous tests have focused on *indirect* measures of failures of the no-bubble condition, by testing the coin-

⁴See Gürkaynak (2008) for a survey of the econometric difficulties in the previous literature; see also Flood and Garber (1980), Diba and Grossman (1988b), and West (1987). The earliest tests focused on bubbles in the price level during hyperinflations. For example,

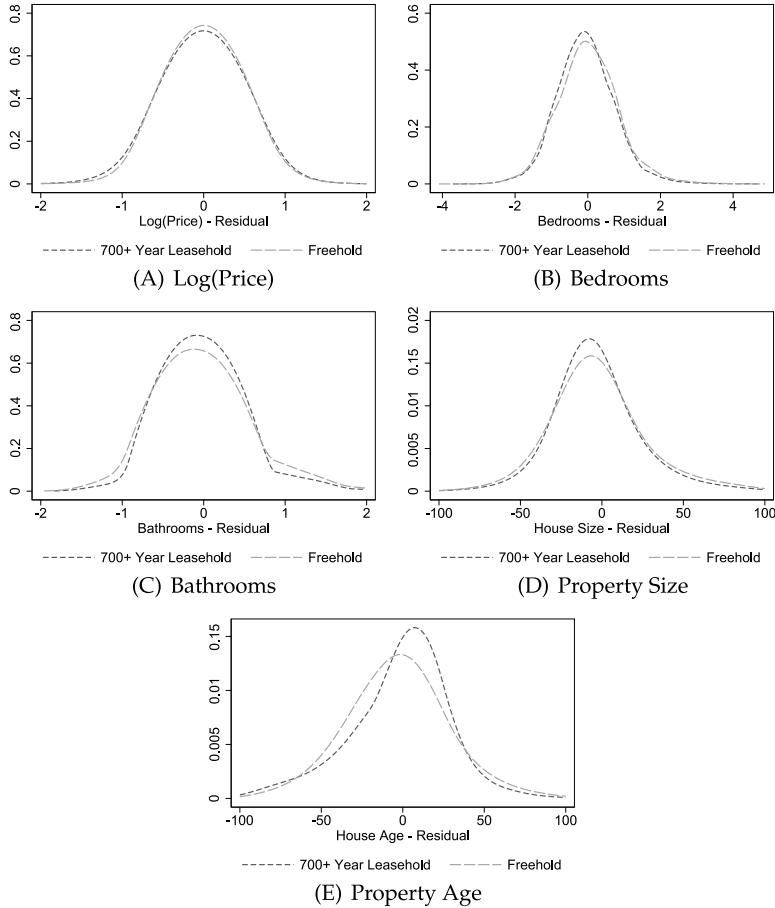


FIGURE A.3.—U.K.—distribution of hedonic characteristics. *Note:* Figures show the distribution of the residuals from regressions of property characteristics on 3-digit postcode by transaction year by property type fixed effects, separately for freeholds and 700+ year leaseholds. The sample is houses sold in the U.K. between 1995 and 2013. The characteristics plotted are: the log of the transaction price (Panel A), the number of bedrooms (Panel B), the number of bathrooms (Panel C), property size in square meters (Panel D), and property age in years (Panel E).

tegration between prices and some transformation of current dividends (Diba and Grossman (1988a)), imposing a structural model of the present discounted value of dividends (Shiller (1981)), or testing model-implied necessary conditions for the existence of a bubble (Abel, Mankiw, Summers, and Zeckhauser (1989)). Given the dependence of the results on the different assumptions

Flood and Garber (1980) tested the rational expectations model of Sargent and Wallace (1973), and found no evidence of bubbles.

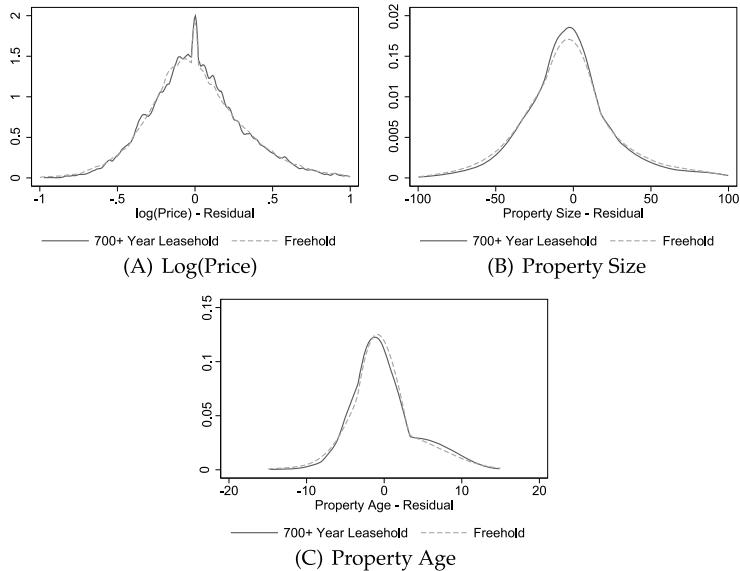


FIGURE A.4.—Singapore—distribution of hedonic characteristics. *Note:* Figures show the distribution of the residuals from regressions of property characteristics on 5-digit postcode \times property type \times title type (land or strata) fixed effects, separately for freeholds and 700+ year leaseholds. The sample is properties sold in Singapore between 1995 and 2013. The characteristics plotted are: the log of the transaction price (Panel A), property size in square meters (Panel B), and property age in years (Panel C).

required in each case, these tests—while influential—were overall inconclusive. For example, [Evans \(1991\)](#) showed that the cointegration test of Diba and Grossman ([1988a](#)) may fail to detect bubbles that periodically collapse.⁵ [Merton et al. \(1985\)](#) highlighted that [Shiller's \(1981\)](#) test is sensitive to the specification of the appropriate fundamental model. [Farhi and Tirole \(2012\)](#) showed that the dynamic-inefficiency conditions tested in Abel et al. ([1989](#))

⁵Within theory models, the origin of bubbles remains unclear, and bubbles are often assumed to be present at the start of the model. Similarly, within many models, a bubble cannot arise again after it has collapsed. Diba and Grossman ([1987, 1988b](#)) pointed out these difficulties, both as theoretical challenges to the existence of rational bubbles, and as empirical problems for their detection. From a theory perspective, proponents of rational bubbles have shown that the inception argument is not stringent. They argue that it is reasonable to think of all assets as having an arbitrarily small, but strictly positive, bubble attached to them at all points in time. These bubbles then only become interesting to economists when they become stochastically “big.” In this world, a bubble collapse is simply a reversion from a state in which the bubble is “big” to one in which it is arbitrarily small. The bubble can then arise again in the future, in the sense that it can stochastically become “big” again. This is the sense in which we refer to collapses or increases in the size of the bubble.

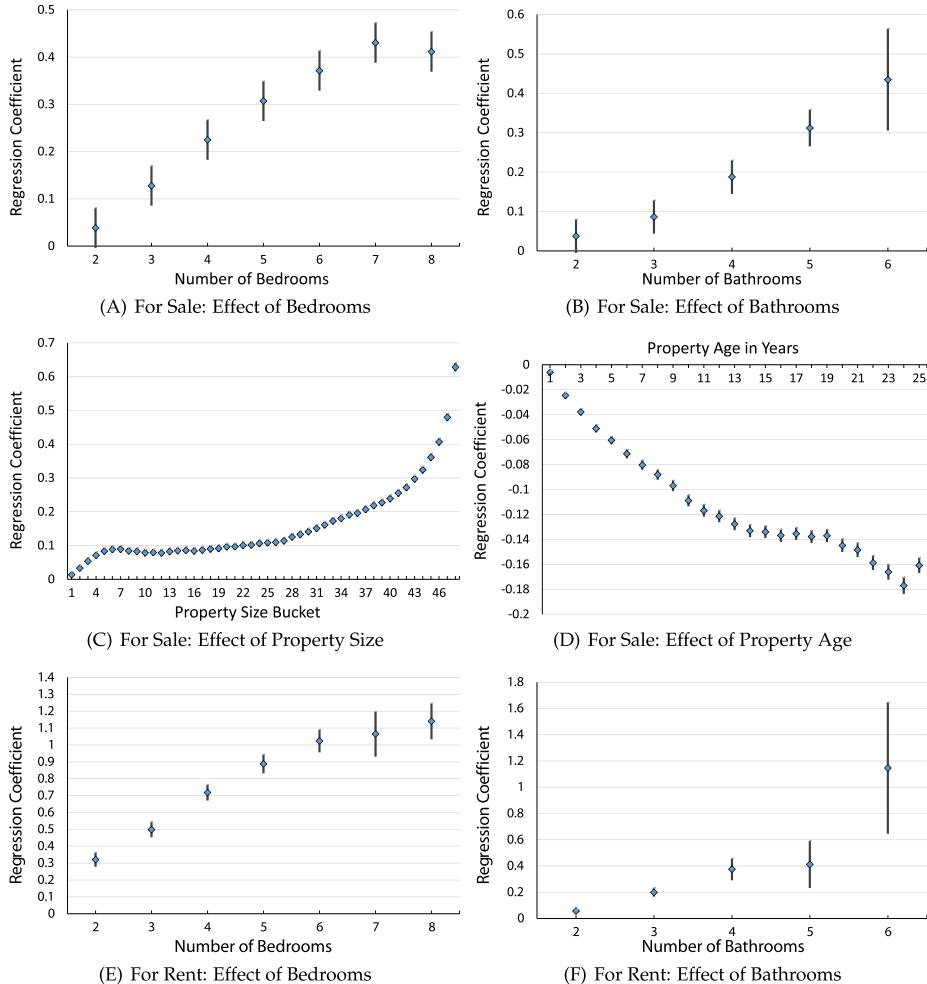


FIGURE A.5.—Price effect of hedonic characteristics—U.K. Note: Figures show coefficients on hedonic controls from regression (3). In Panels A–D, the dependent variable is the log price paid for houses in England and Wales between 1995 and 2013. Panel A shows coefficients on indicators for the number of bedrooms, Panel B on indicators for the number of bathrooms, Panel C on 50 equally sized property size bucket indicators, and Panel D on indicators for property age. The regression includes other control variables and fixed effects as in column 1 of Table II. In Panels E and F, the dependent variable is the log rental listing price for all houses listed as “for rent” on Rightmove.co.uk and Zoopla.co.uk on March 30, 2015. Panel E shows coefficients on the number of bedrooms, Panel F on the number of bathrooms. We also include other control variables and fixed effects as in column 3 of Table IV. For every characteristic, the first bucket is omitted from the regression to avoid collinearity. The bars show 95% confidence intervals for standard errors clustered at the 3-digit postcode level.

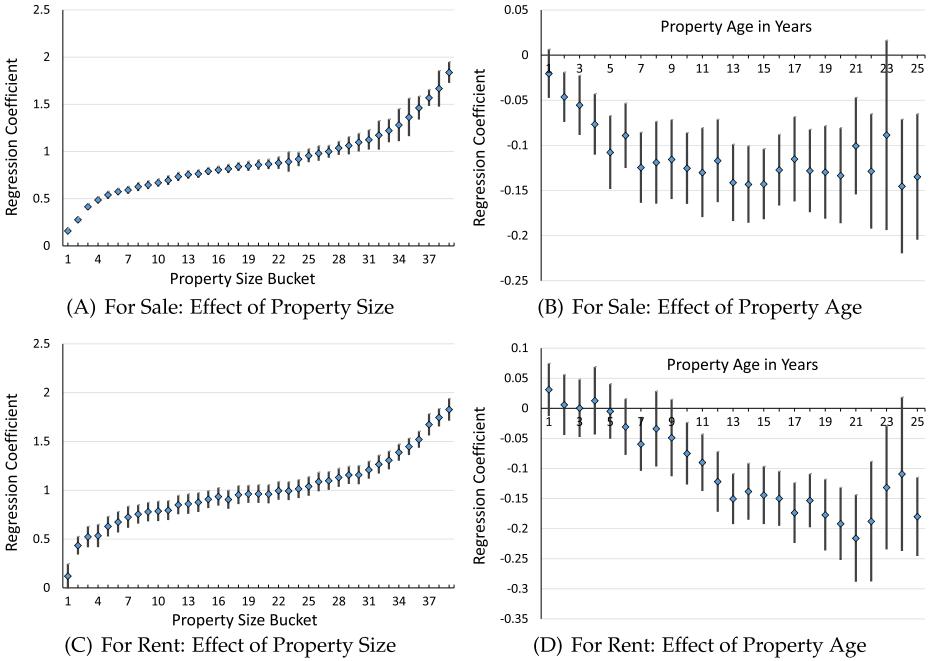


FIGURE A.6.—Singapore—price effect of hedonic characteristics. *Note:* Figures show coefficients on hedonic controls from regression (3). In Panels A and B, the dependent variable is the log price paid for properties sold in Singapore between 1995 and 2013. Panel A shows the coefficients on 40 equally sized property size bucket indicators, Panel B on indicator variables for property age. The regression includes other control variables and fixed effects as in column 5 of Table II. In Panels C and D, the dependent variable is the log rental listing price for all properties listed “for rent” on [iProperty.com.sg](#) between 2010 and 2013. Panel C shows the coefficients on 40 equally sized property size bucket indicators, Panel D on indicator variables for property age. The regression includes other control variables and fixed effects as in column 1 of Table IV. For every characteristic, the first bucket is omitted from the regression to avoid collinearity. The bars show 95% confidence intervals for standard errors that are clustered at the 5-digit postcode level.

are no longer necessary for the existence of bubbles in the presence of financial frictions.⁶

We next discuss briefly the tests that focus on the relative growth rate of bubbles and the economy. A necessary condition for bubbles to occur on assets in positive net supply, such as real estate, is that the bubble cannot asymptotically grow faster than the growth rate of the economy. Intuitively, if the bubble were to grow faster than the economy, it would eventually overtake the entire wealth

⁶On the possible misspecification of Shiller’s (1981) volatility bounds as a test for classic rational bubbles, see Mankiw, Romer, and Shapiro (1985) and Flood and Hodrick (1986). Geerolf (2014) found favorable evidence for the dynamic inefficiency of advanced economies, and linked it to the empirical plausibility of asset bubbles.

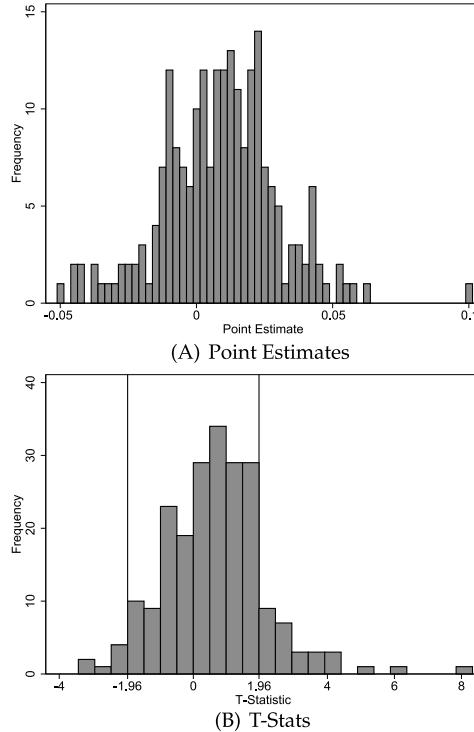


FIGURE A.7.—Postcode-area \times year coefficients. *Note:* Panel A shows a histogram of the price difference between extremely-long leaseholds and freeholds, obtained by separately estimating regression (3) in each of the 217 postcode area-years with at least 1,000 transactions, of which at least 10% are for extremely-long leaseholds and at least 10% are for freeholds. For each postcode area-year, we control for quarter fixed effects and 5-digit postcode fixed effects. Panel B shows a histogram of the associated t -statistics.

of the economy as long as wealth and output are cointegrated. However, this does not mean that a classic rational bubble cannot occur in real estate markets. In fact, bubbles can exist (and grow at a low rate asymptotically) even on assets that, on average, have high returns, for two main reasons. First, the bubble can have different risk properties than the asset it pertains to; hence, it is quite possible that even a risky, high-return asset such as housing has a bubble component that is relatively safe and grows at a lower pace in the very long run.⁷ Second, in an economy with frictions, the rate of return on the asset can be higher than the rate at which the bubble grows, even if the bubble and the underlying asset are equally risky ([Farhi and Tirole \(2012\)](#)). These results do not overturn the necessary condition for the existence of a bubble derived

⁷This is the case, for example, in [Galí's \(2014\)](#) economy, where the bubble is attached to risky capital, but the bubble itself is purely idiosyncratic and therefore earns the risk-free rate of return.

by [Tirole \(1985\)](#), namely that the long-run growth rate of the bubble should be less than that of the economy, but they restore the theoretical case for bubbles by showing that such a condition could easily be satisfied in realistic setups. In addition, Tirole's restrictions are about the *long-run* (asymptotic) expected behavior of the bubble, and impose no structure on its short-run behavior, which can include periods of very rapid price growth.

We proceed as follows: first, we review the theory of the integration and cointegration tests, covering the original tests of [Diba and Grossman \(1988a\)](#) as well as the subsequent literature that extended those tests to overcome some of the shortcomings of the original approach. We then apply these tests to our data on the U.K. and Singapore housing markets.

A.2.1. Integration and Cointegration Tests for Rational Bubbles

Under the assumption of constant discount rates, the price of an asset is given by⁸

$$(A.1) \quad P_t = \sum_{j=1}^{\infty} \frac{1}{(1+r)^j} E_t[D_{t+j}] + B_t,$$

where the bubble component B_t satisfies the difference equation:

$$E_t[B_{t+1}] = (1+r)B_t \quad \text{with } B_0 > 0.$$

The bubble grows on average at rate $r > 0$, and, as noted in [Diba and Grossman \(1988b\)](#), has to be strictly positive at all times. [Diba and Grossman \(1988a\)](#) studied how these features of the bubble affect the stationarity of the price process, P_t . In particular, they observed that under the null hypothesis of no bubble, the degree of integration of P_t is the same as that of D_t . For example, if dividends are stationary, prices are also stationary; if dividends have a unit root, prices will inherit that unit root. On the contrary, the presence of a bubble introduces an explosive component in prices that is not present in dividends. This implication of a rational bubble yields two empirical tests that we review below.

A.2.1.1. The Right-Tailed ADF Test

[Diba and Grossman \(1988a\)](#) proposed a test whereby a bubble is detected in the data if prices are integrated of higher order than dividends. For example, a bubble is detected if first differences in prices are integrated of at least

⁸It is typical in this literature to assume constant discount rates for mathematical convenience. As long as discount rates are stationary, the cointegration properties of prices are minimally affected by the presence of the additional transitory component induced by time-variation in discount rates. This transitory component becomes more important for the tests if the discount rates are extremely persistent. For more details, see [Craine \(1993\)](#), [Timmermann \(1995\)](#), and [Phillips and Yu \(2011\)](#).

order 1, while dividends in levels are stationary or have a unit root. Tests for explosive patterns in prices can be performed using right-tailed Augmented Dickey–Fuller (ADF) tests. ADF tests can be used to test for a unit root in the variable of interest (P_t or D_t) against the stationary alternative (left-tailed test), or against the explosive alternative (right-tailed test). Since the limiting distribution for the test statistic is nonstandard, critical values for the test are obtained via Monte Carlo simulations. Phillips, Shi, and Yu (2014a) emphasized that the choice of the regression specification employed to perform the ADF test is important, because the regression needs to nest plausible specifications either under the null or under the preferred alternative model. To test for stationarity against a unit root, we use the standard general specification of the ADF test:

$$(A.2) \quad x_t = a + bt + \delta x_{t-1} + \sum_{j=1}^k \phi_j \Delta x_{t-j} + e_t.$$

The null hypothesis in the ADF test is that $\delta = 1$, and the alternative hypothesis is that $\delta < 1$.⁹ We allow for the linear trend term, bt , while specifying that under the null model $b = 0$, to capture the possibility that under the alternative model x_t might be stationary around a trend.

Phillips, Shi, and Yu (2014a) argued that when testing for the presence of an explosive root as an alternative hypothesis (right-tailed test), the specification (A.2), as used in Diba and Grossman (1988a), is not appropriate, because in this case both the null and the alternative models feature $b = 0$. They suggested that for right-tailed tests a better specification imposes $b = 0$, and specifies

$$x_t = \alpha + \delta x_{t-1} + \sum_{j=1}^k \phi_j \Delta x_{t-j} + e_t.$$

The null hypothesis is still $\delta = 1$, but the alternative hypothesis is now $\delta > 1$. We follow this suggested specification in our implementation of the right-sided test.¹⁰

A.2.1.2. Cointegration Tests

Diba and Grossman (1988a) proposed a second test which directly exploits the restriction that, under the null hypothesis of no rational bubble, not only

⁹An F -test for the joint hypothesis that $\delta = 1$ and $b = 0$ has also been proposed. However, this test is not one-sided, and in the bubbles test we want to keep separate the deviation from the null towards stationarity and the presence of explosive roots, so we will confine ourselves to one-sided tests.

¹⁰Following Phillips, Shi, and Yu (2014a), we also allow for an asymptotically negligible drift in prices under the null, equal to T^{-1} .

should prices and dividends have the same degree of integration, but they should also be cointegrated. A rational bubble breaks the cointegration by inducing a more explosive pattern in prices than in dividends. The intuition behind this argument can be understood, for example, by using the Campbell and Shiller (1987) log-linearization of Equation (A.1) under $B_t = 0, \forall t$, which yields

$$(A.3) \quad p_t - d_t = h + \sum_{j=0}^{\infty} \rho^j E_t[\Delta d_{t+1+j}],$$

$$\rho = \frac{1}{1 + \exp(\bar{d} - \bar{p})},$$

$$h = \frac{-\log(\rho) + (1 - \rho) \log\left(\frac{1}{\rho} - 1\right) - r}{1 - \rho},$$

where lowercase variables denote logarithms, so that, for example, $p_t = \log(P_t)$. r is the (constant) expected return on the asset, and $\bar{d} - \bar{p}$ is the average log dividend-price ratio. Campbell and Shiller (1987) pointed out that in the absence of a rational bubble, the log price-dividend ratio is stationary as long as dividend growth is stationary. Diba and Grossman (1988a) tested this restriction with a cointegration test for log-prices and log-dividends.

A.2.1.3. *The SADF Test*

While theoretically appealing, the original tests by Diba and Grossman (1988a) described above have important drawbacks. Evans (1991) pointed out that, in finite samples, these tests have low power to detect the presence of rational bubbles that periodically collapse. Intuitively, a price series with a collapsing bubble may look stationary if the sample is short enough, since the price would appear to revert to the mean when the bubble collapses. This observation has limited the applicability of the original tests, and has prompted the subsequent literature to develop more sophisticated econometric tests aimed at overcoming this limitation.

Among this new class of tests, an important extension of the right-tailed ADF test that explicitly allows for periodically collapsing rational bubbles was developed by Phillips, Wu, and Yu (2011). This test exploits the idea that if a rational bubble is present in sample, but might collapse at some point, prices may not display explosive behavior when the full sample is considered, but should behave in an explosive way up to the collapse of the bubble. The procedure looks for such periods by testing for explosive behavior in all subsamples from time t_1 (the initial period of the sample, kept fixed) up to all possible end dates of the bubble t_2 . This test is denoted sup-ADF (SADF), because it is constructed by taking the *sup* across the ADF statistic in all the subsamples.

In particular, denote by ADF_ε the ADF statistic obtained using data from time 0 up to time $[\varepsilon T]$, where $\varepsilon \in (0, 1)$, T is the total sample size, and the operator $[\cdot]$ returns the integer part of its argument. The test statistic tends in distribution to

$$ADF_\varepsilon \rightarrow \frac{\int_0^\varepsilon \tilde{W}(r) dW(r)}{\left(\int_0^\varepsilon \tilde{W}(r)^2 dr\right)^{1/2}},$$

where W is a standard Brownian motion and $\tilde{W}(r) = W(r) - \int_0^1 dW(r)$. The sup-ADF test has the limiting distribution

$$SADF = \sup_{\varepsilon \in [\varepsilon_0, 1]} ADF_\varepsilon \rightarrow \sup_{\varepsilon \in [\varepsilon_0, 1]} \frac{\int_0^\varepsilon \tilde{W}(r) dW(r)}{\left(\int_0^\varepsilon \tilde{W}(r)^2 dr\right)^{1/2}},$$

where ε_0 is the minimum window size considered for the bubble test. Optimal choice methods for ε_0 were discussed in [Phillips, Wu, and Yu \(2011\)](#), and the critical values for the test are obtained by Monte Carlo simulation. In addition, the procedure allows to estimate the origination date ε_e and the collapse date ε_f of the bubble, as described in [Phillips, Wu, and Yu \(2011\)](#), by choosing the earliest and latest date in which the ADF_ε statistic is above its corresponding critical value.

Note that both the ADF and the SADF tests for explosive patterns are right-tailed tests, in which the null hypothesis is that prices are unit root, and the alternative hypothesis is that rational bubbles are present in the sample. Rejecting the null (when the test statistic is larger than the critical values) indicates the presence of a (potentially periodically collapsing) rational bubble in the data.

A.2.1.4. *The GSADF Test*

[Phillips, Shi, and Yu \(2014b\)](#) noted that the methodology developed in [Phillips, Wu, and Yu \(2011\)](#) may still fail to detect bubbles if more than one bubble is present in the sample. To address this, [Phillips, Shi, and Yu \(2014b\)](#) developed a further extension of the SADF test that tests for bubbles in *every* subperiod t_1 to t_2 in the data (in this case, t_1 is not kept fixed to be the initial date of the sample). This test is denoted as the generalized-sup-ADF (GSADF) test.

The intuition behind this procedure is to test for the presence of a collapsing bubble using the SADF test in every subsample of the data: while the SADF

test can detect one bubble in the sample it analyzes, different SADF tests conducted over different windows are able to detect many separate bubbles. The GSADF test is given by

$$GSADF = \sup_{\varepsilon_2 \in [\varepsilon_0, 1], \varepsilon_1 \in [0, \varepsilon_2 - \varepsilon_0]} ADF_{\varepsilon_1}^{\varepsilon_2},$$

where $ADF_{\varepsilon_1}^{\varepsilon_2}$ is the standard ADF test constructed using the sample from $[\varepsilon_1 T]$ to $[\varepsilon_2 T]$. Phillips, Shi, and Yu (2014b) also showed how to provide estimates of the start and end dates of the bubbles by looking at a backward-looking *SADF* test across subperiods. In what follows, we apply the ADF, SADF, and GSADF tests to the U.K. and Singapore housing markets, using a significance threshold of 5% to identify periods with bubbles.¹¹

A.2.2. Data and Empirical Tests

We implement the above tests for classic rational bubbles on house price and rent series for the U.K. and Singapore, and for various U.K. regions. For the aggregate U.K. housing market, our real house price series covers the period 1952–2013, and our real rent series covers the period 1996–2013.¹² For Singapore, our real house price series covers the period 1975–2012, and our real rent series covers the period 1990–2013.¹³ For all of the subregions of the U.K., we estimate the price at the subregion level by estimating our hedonic model in each region, and taking the quarter fixed effects, deflated using CPI (ONS series D7BT).

Note that the short samples for rent series limit the implementability of integration tests for rents and cointegration tests for rents and house prices. Of course, this limitation does not apply to tests that only require house price data.

We implement the tests using the log, rather than the level, of prices and rents because a linear trend in the alternative model of a number of the tests is more plausible when considering log prices and dividends rather than levels. The (unreported) results are very similar when using levels.

A.2.2.1. Cointegration Tests

Following Diba and Grossman (1988a), we look at the cointegration between log prices and log rents (only for the aggregate U.K. series and Singapore, since

¹¹Our implementation of the time-series tests is heavily based on the code for the SADF, GSADF, and bubble-dating tests available on Shu-Ping Shi's website, at <https://sites.google.com/site/shupingshi/home/research>. We are grateful to the authors for making the code available. The code was retrieved on 3/15/2015.

¹²Both series are at the annual frequency. Nominal house prices are from Nationwide. Rents are obtained from the Office of National Statistics, code D7CE (actual rents for housing). Inflation is obtained from the Office of National Statistics, code CDKO.

¹³Both series are at the quarterly frequency. Nominal house prices and rents are from the Urban Redevelopment Authority. Inflation is obtained from the national accounts (http://www.singstat.gov.sg/statistics/browse_by_theme/prices.html).

we only have rent data at the aggregate level). In particular, Campbell and Shiller (1987) noted that economic theory constrains the cointegrating vector between prices and rents to be $[1, -1]$, that is, the *difference* $p_t - d_t$ should be stationary in the absence of a rational bubble. We can test this restriction by performing a left-tailed ADF test on the time series $p_t - d_t$. The null hypothesis is that there is a unit root in the series, while the alternative hypothesis—derived from economic theory—is that the series is stationary (without deterministic trends). We cannot reject the null of a unit root in the price-rent ratio for either country (ADF statistics are -1.91 in the U.K. and -2.37 in Singapore, with 10% left-sided finite-sample critical values of -2.68 and -2.58 , respectively). These tests, therefore, are a first indication that a rational bubble might be present in these markets.

A.2.2.2. Tests for Explosive Patterns in Prices

We also implement the tests in Phillips, Wu, and Yu (2011) and Phillips, Shi, and Yu (2014b) that extend the original tests in Diba and Grossman (1988a). In addition to testing for bubbles in the aggregate time series of the U.K. and Singapore, we also perform the analysis on different regions within the U.K.: London, Prime Central London (PCL), and the set of all postcode areas with at least 20,000 transactions (of which there are 100).

Table A.I reports tests for rational bubbles using the ADF test, the sup-ADF (SADF) test, and the generalized sup-ADF (GSADF) test to check for explo-

TABLE A.I
TIME-SERIES TESTS OF RATIONAL BUBBLES^a

Series	U.K. (Prices)	SG (Prices)	London (Prices)	PCL (Prices)
ADF stat	-1.19	-1.80	-1.92	-2.01
10% CV	-0.47	-0.41	-0.43	-0.43
5% CV	-0.09	-0.03	-0.06	-0.06
1% CV	0.74	0.64	0.52	0.52
SADF stat	1.11*	2.32***	1.39**	0.92
10% CV	0.94	1.02	0.95	0.95
5% CV	1.22	1.30	1.26	1.26
1% CV	1.84	1.90	1.86	1.86
GSADF stat	1.67*	3.49***	2.22**	2.01**
10% CV	1.59	1.78	1.65	1.65
5% CV	1.89	2.05	1.95	1.95
1% CV	2.63	2.65	2.56	2.56

^aTable shows results of the right-tailed ADF, SADF, and GSADF tests for unit roots against the alternative hypothesis that the series is explosive. The first row of each set reports the statistic, and the remaining rows report the small-sample critical values obtained from simulations. Each column performs the test on a different time series: yearly real log house prices for the U.K. (from Nationwide), quarterly real log house prices for Singapore (from URA), quarterly real log house prices for London and PCL (our estimates from the hedonic regression, deflated using U.K. CPI, series D7BT of the ONS). The sample for the U.K. is 1952–2013; the sample for Singapore is 1975–2013. The sample for London and PCL is 1995–2013. Significance levels for the test: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

TABLE A.II
CHARACTERISTICS OF BUYERS OF LEASEHOlds AND FREEHOlds: U.K. HOUSES^a

	Sample		Leasehold Δ		
	Mean (1)	St. Dev. (2)	Unconditional (3)	Conditional I (4)	Conditional II (5)
Age Head of Household (years)	52.14	15.97	-1.79	-0.75 (0.22)	-0.51 (0.21)
Weekly Income (£)	414.7	471.8	-81.4	-10.6 (4.60)	0.83 (4.34)
Number of People in Household	2.54	1.26	-0.03	-0.04 (0.02)	0.01 (0.02)
Number of Dependent Children	0.54	0.94	-0.01	-0.01 (0.01)	0.02 (0.01)
Head of Household Married	0.64	0.48	-0.03	-0.01 (0.01)	0.01 (0.01)
First Time Buyer	0.40	0.49	0.06	-0.02 (0.01)	-0.02 (0.01)
Currently Has Mortgage	0.59	0.49	0.02	0.00 (0.01)	-0.01 (0.01)
Very Satisfied With Neighborhood	0.48	0.50	-0.06	0.01 (0.01)	0.01 (0.01)

^aTable shows summary statistics on characteristics of owners of freehold houses and leasehold houses in the Survey of English Housing. The data contain information on 187,335 households in England surveyed between 1993 and 2007. The first two columns provide the sample means and standard deviations of the outcome variables. Column 3 shows the unconditional average difference between leasehold owners and freehold owners (e.g., on average, heads of households owning leasehold properties are 1.8 years younger than heads of households owning freehold properties). Columns 4 and 5 show the β coefficient of the following regression: $\text{Outcome}_i = \alpha + \beta \text{Leasehold}_i + \xi X_i + \phi \text{Property Type} \times \text{Region} \times \text{Year} + \varepsilon_i$. Column 4 does not include any additional controls in X_i , column 5 includes dummy variables for property age and the number of rooms. Standard errors are clustered at the level of the fixed effects.

sive patterns in house price series, for the U.K., Singapore, London, and PCL. Note that the procedures by Phillips, Wu, and Yu (2011) and Phillips, Shi, and Yu (2014b) can be used to detect explosive patterns either in the price series p_t or in the price-rent ratio $p_t - d_t$.¹⁴ Here we focus on the real price series, given the short sample of rents available. The test is a right-tailed test of a unit root against the alternative of an explosive process.¹⁵

The results of the right-tailed tests are striking: while the full-sample ADF test fails to find explosive patterns, both the sup-ADF and the generalized sup-ADF tests find statistically significant evidence in favor of rational bubbles in

¹⁴Phillips, Wu, and Yu (2011) focused on the price series, while Phillips, Shi, and Yu (2014b) focused on the price-rent ratio. Pavlidis, Yusupova, Paya, Peel, Martinez-Garcia, Mack, and Grossman (2013) performed their analysis on both.

¹⁵The alternative model does not allow for a time trend, for the reasons discussed above and in Phillips, Shi, and Yu (2014a). Lag order is selected using the BIC criterion.

the U.K. and in Singapore, as well as in London and in PCL. Overall, the time-series evidence (both using cointegration restrictions and ADF tests) strongly supports the presence of a classic rational bubble in these markets. These time-series tests can also be used to identify the beginning and end dates of the bubbles they detect. Figure 1 plots the time-series of real house prices for the U.K. and Singapore, and shades periods in which a bubble was detected at the 5% level, using the rolling SADF test as described in Phillips, Shi, and Yu (2014b). The bubble-dating procedure clearly identifies strong run-ups in prices as bubbles. In particular, for the U.K. it identifies two bubbly episodes: 1971–1973 and 2002–2004.¹⁶ For Singapore, it identifies three bubbly subperiods: 1980–1981, 1992–1996, and 2007. In Appendix Figures A.8 to A.17, we also plot the time-series of real log prices and the periods where the tests identify a bubble for London, PCL, and all 100 U.K. postcode areas. Consistent with the ag-

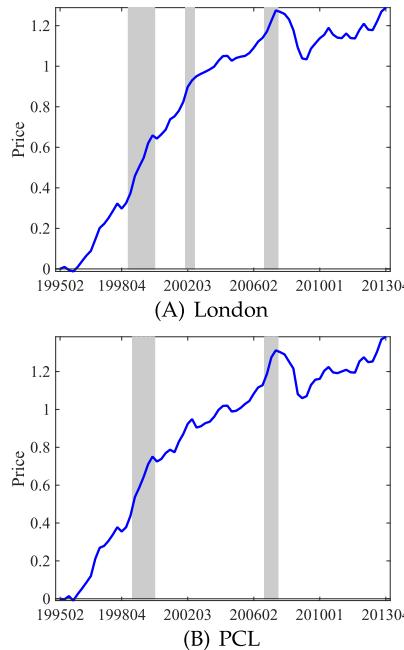


FIGURE A.8.—London—house price series. *Note:* Figure shows quarterly real log house prices for London and PCL between 1995 and 2013, obtained by running a hedonic regression of log transaction prices on property characteristics and indicators for the transaction quarter. The hedonic price index is constructed as the coefficients on the quarter indicators deflated by U.K. CPI (series D7BT from ONS). Shaded areas show the periods in which the Phillips, Shi, and Yu (2014b) test detects a classic rational bubble at the 5% confidence level (see Appendix A.2.2.2).

¹⁶Note that the bubble does not appear statistically significant in 2003, but is significant in both 2002 and 2004.

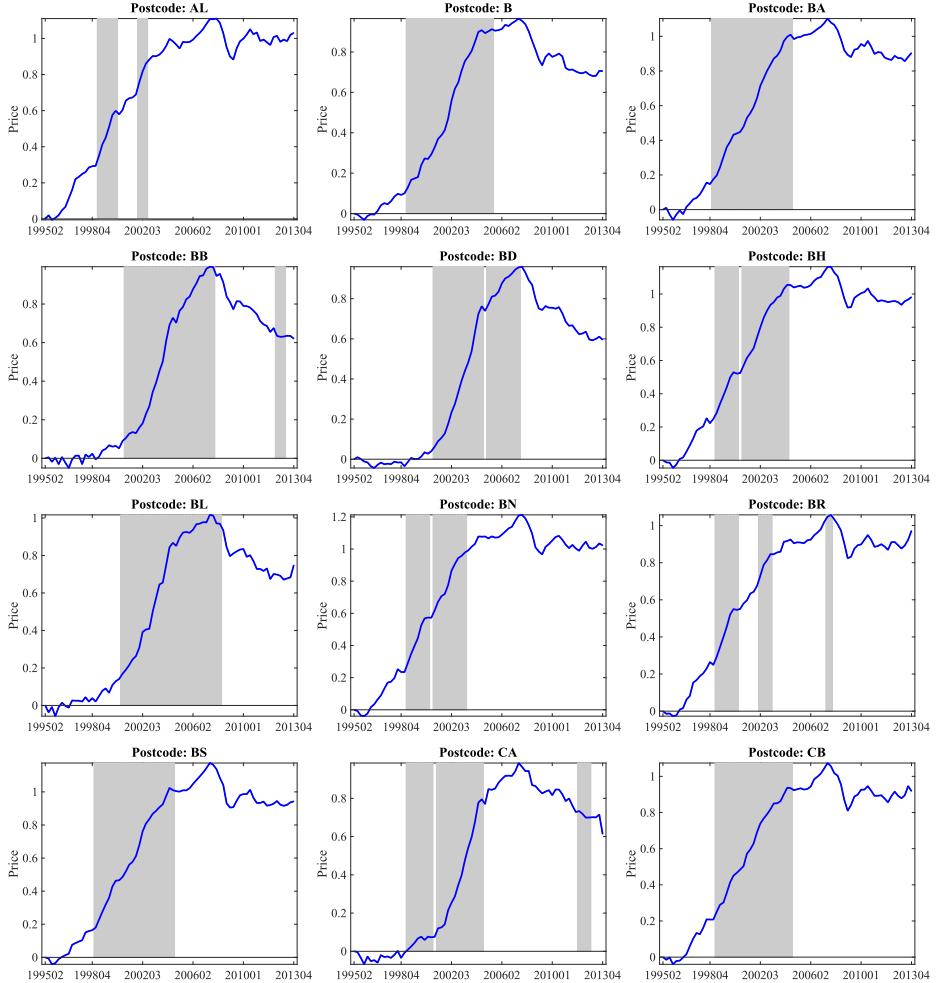


FIGURE A.9.—U.K. postcode areas—house price series. *Note:* Figures show quarterly real log house prices for U.K. postcode areas between 1995 and 2013, obtained by running a hedonic regression of log transaction prices on property characteristics and indicators for the transaction quarter. The hedonic price index is constructed as the coefficients on the quarter indicators deflated by U.K. CPI (series D7BT from ONS). Shaded areas show the periods in which the Phillips, Shi, and Yu (2014b) test detects a classic rational bubble at the 5% confidence level (see Appendix A.2.2.2).

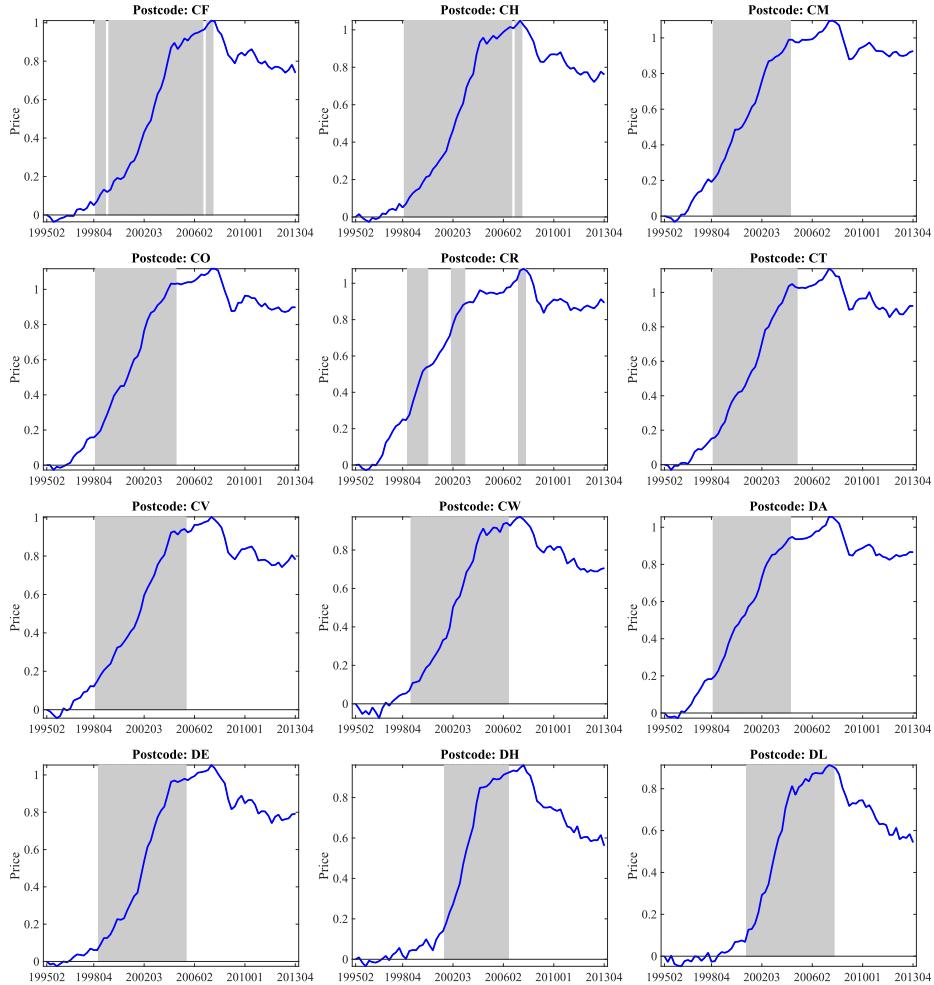


FIGURE A.10.—U.K. postcode areas—house price series. *Note:* Figures show quarterly real log house prices for U.K. postcode areas between 1995 and 2013, obtained by running a hedonic regression of log transaction prices on property characteristics and indicators for the transaction quarter. The hedonic price index is constructed as the coefficients on the quarter indicators deflated by U.K. CPI (series D7BT from ONS). Shaded areas show the periods in which the Phillips, Shi, and Yu (2014b) test detects a classic rational bubble at the 5% confidence level (see Appendix A.2.2.2).

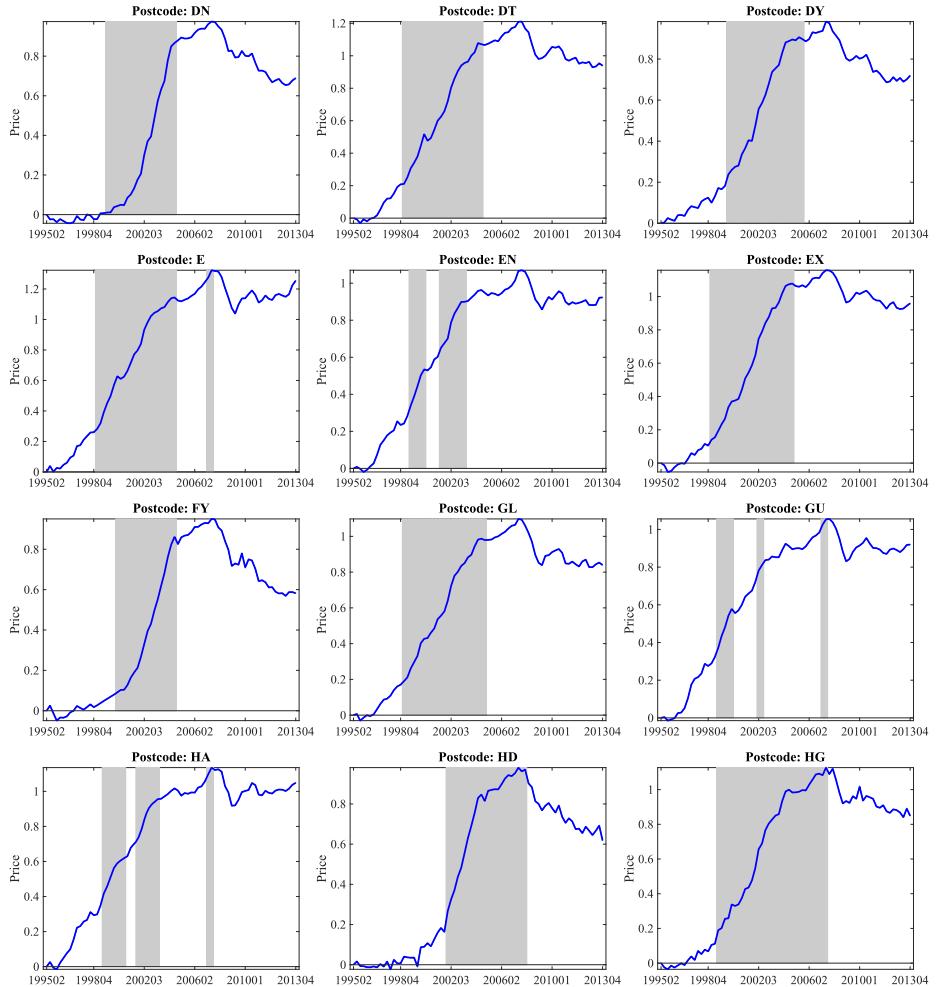


FIGURE A.11.—U.K. postcode areas—house price series. *Note:* Figures show quarterly real log house prices for U.K. postcode areas between 1995 and 2013, obtained by running a hedonic regression of log transaction prices on property characteristics and indicators for the transaction quarter. The hedonic price index is constructed as the coefficients on the quarter indicators deflated by U.K. CPI (series D7BT from ONS). Shaded areas show the periods in which the Phillips, Shi, and Yu (2014b) test detects a classic rational bubble at the 5% confidence level (see Appendix A.2.2.2).

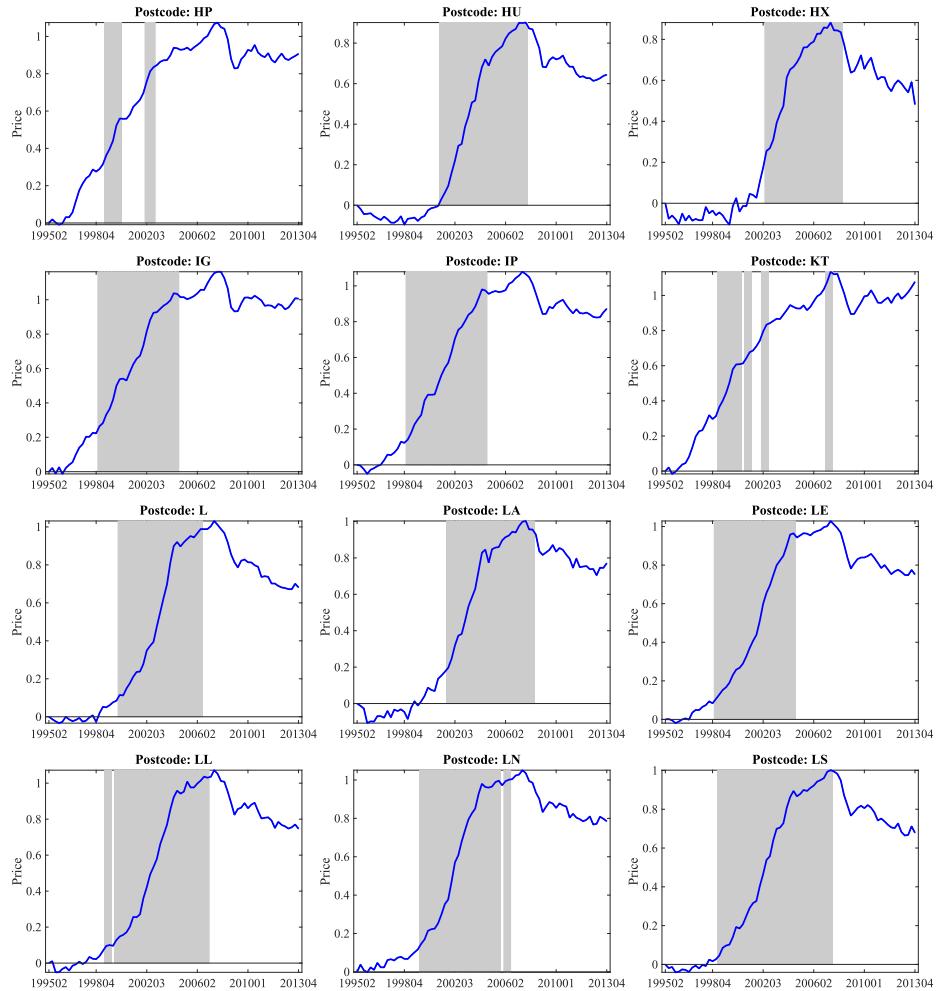


FIGURE A.12.—U.K. postcode areas—house price series. *Note:* Figures show quarterly real log house prices for U.K. postcode areas between 1995 and 2013, obtained by running a hedonic regression of log transaction prices on property characteristics and indicators for the transaction quarter. The hedonic price index is constructed as the coefficients on the quarter indicators deflated by U.K. CPI (series D7BT from ONS). Shaded areas show the periods in which the Phillips, Shi, and Yu (2014b) test detects a classic rational bubble at the 5% confidence level (see Appendix A.2.2.2).

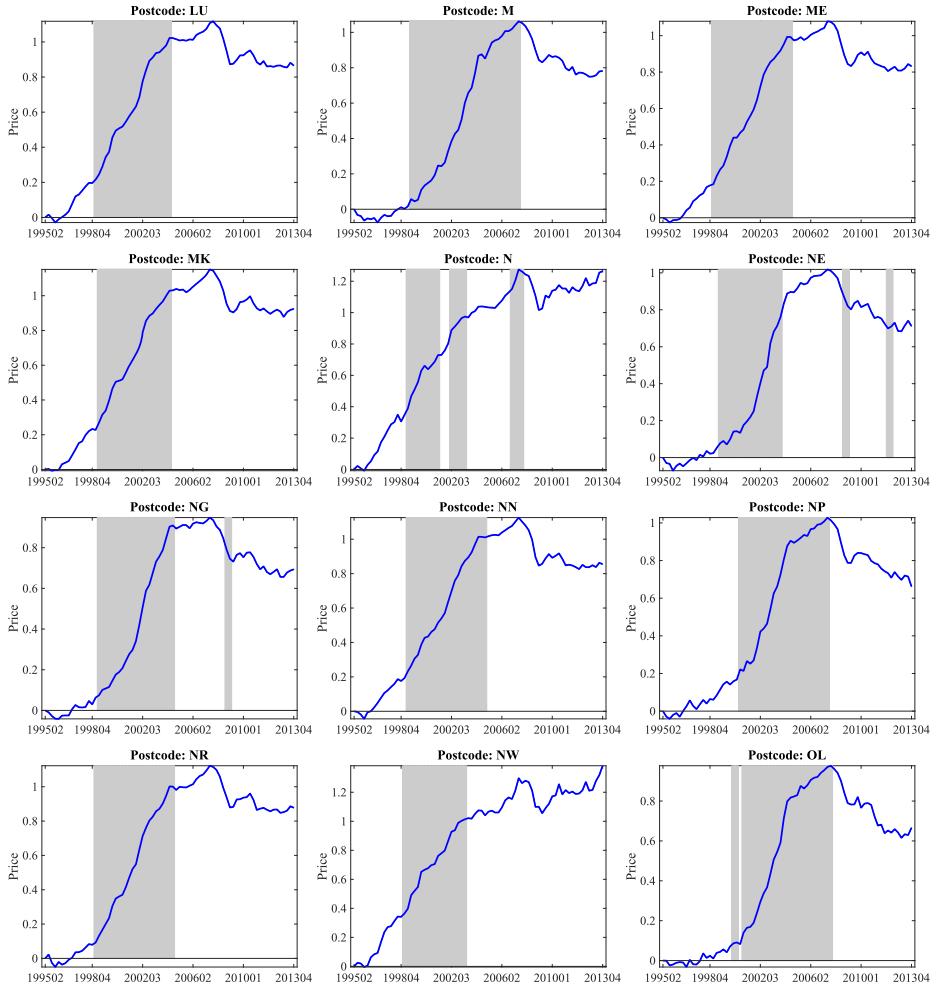


FIGURE A.13.—U.K. postcode areas—house price series. *Note:* Figures show quarterly real log house prices for U.K. postcode areas between 1995 and 2013, obtained by running a hedonic regression of log transaction prices on property characteristics and indicators for the transaction quarter. The hedonic price index is constructed as the coefficients on the quarter indicators deflated by U.K. CPI (series D7BT from ONS). Shaded areas show the periods in which the Phillips, Shi, and Yu (2014b) test detects a classic rational bubble at the 5% confidence level (see Appendix A.2.2.2).

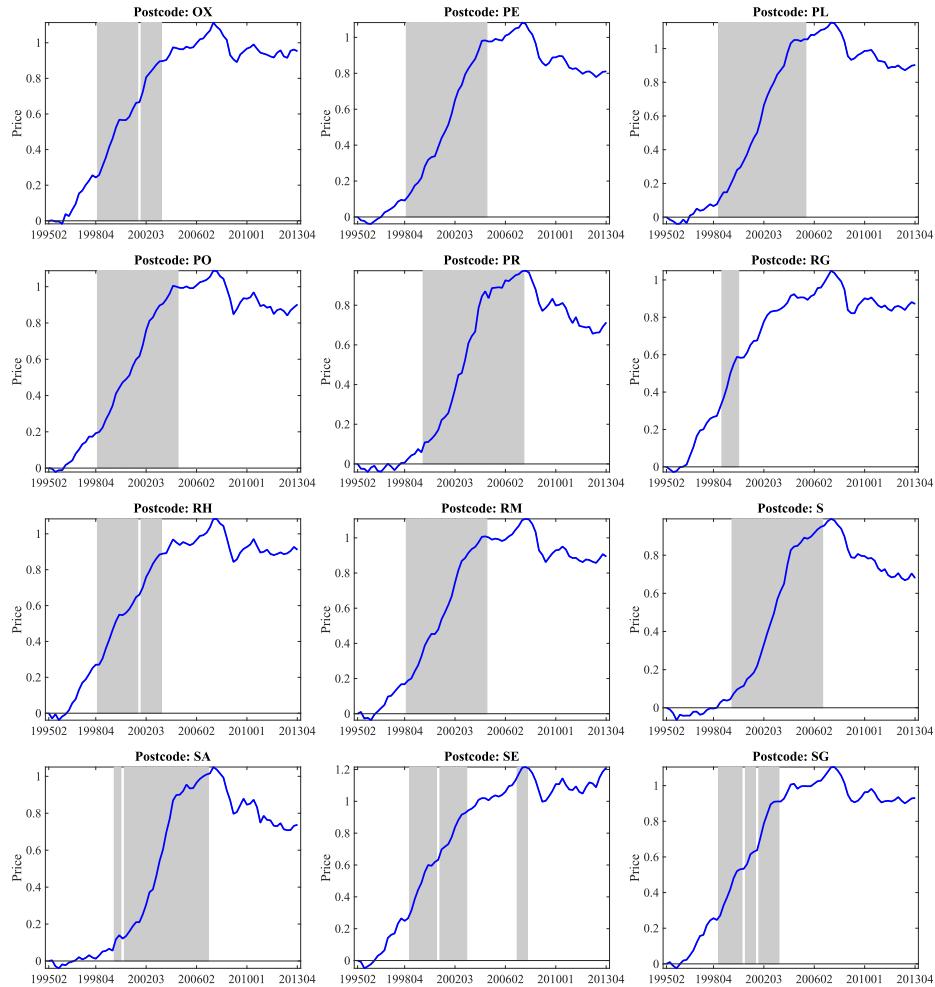


FIGURE A.14.—U.K. postcode areas—house price series. *Note:* Figures show quarterly real log house prices for U.K. postcode areas between 1995 and 2013, obtained by running a hedonic regression of log transaction prices on property characteristics and indicators for the transaction quarter. The hedonic price index is constructed as the coefficients on the quarter indicators deflated by U.K. CPI (series D7BT from ONS). Shaded areas show the periods in which the Phillips, Shi, and Yu (2014b) test detects a classic rational bubble at the 5% confidence level (see Appendix A.2.2.2).

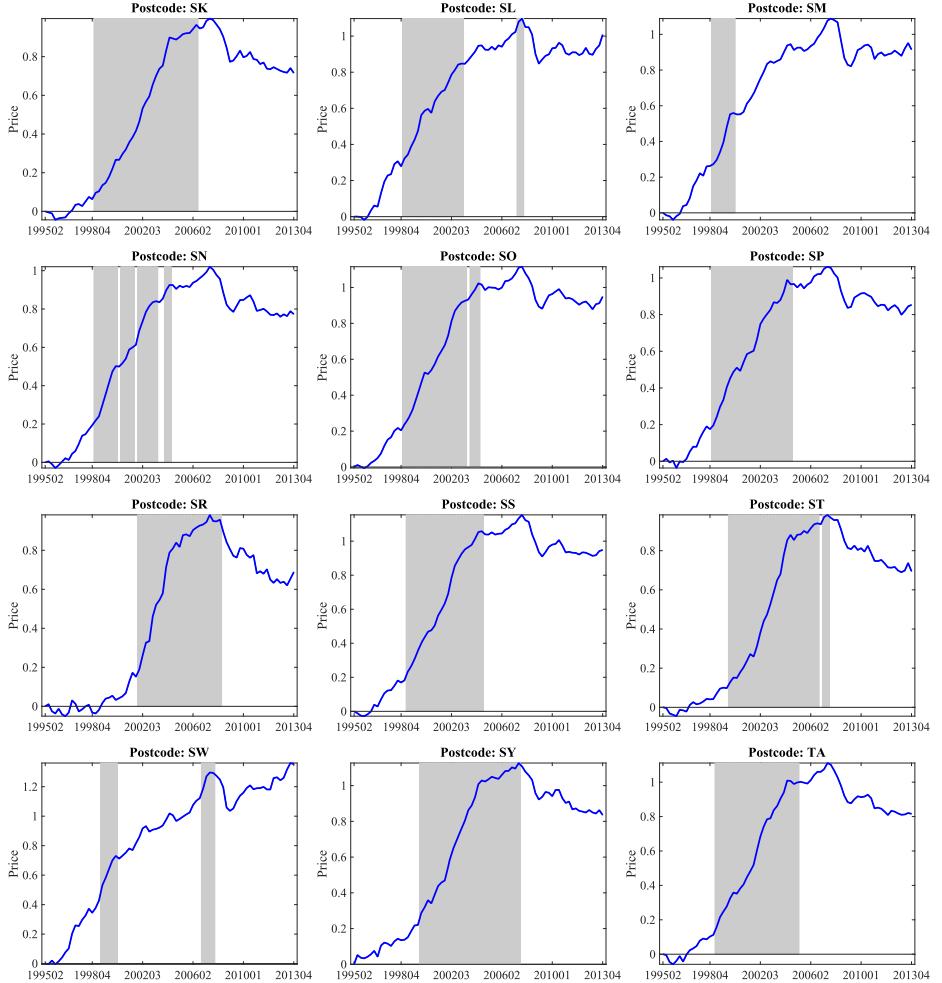


FIGURE A.15.—U.K. postcode areas—house price series. *Note:* Figures show quarterly real log house prices for U.K. postcode areas between 1995 and 2013, obtained by running a hedonic regression of log transaction prices on property characteristics and indicators for the transaction quarter. The hedonic price index is constructed as the coefficients on the quarter indicators deflated by U.K. CPI (series D7BT from ONS). Shaded areas show the periods in which the Phillips, Shi, and Yu (2014b) test detects a classic rational bubble at the 5% confidence level (see Appendix A.2.2.2).

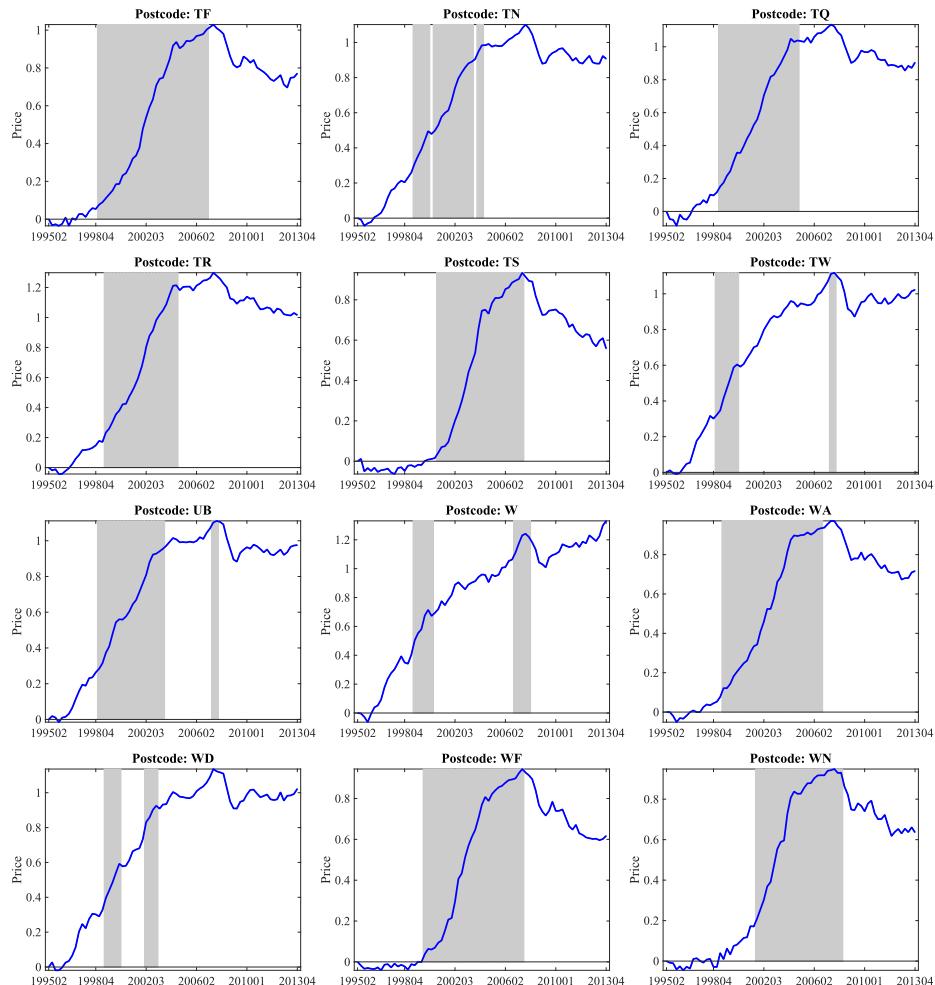


FIGURE A.16.—U.K. postcode areas—house price series. *Note:* Figures show quarterly real log house prices for U.K. postcode areas between 1995 and 2013, obtained by running a hedonic regression of log transaction prices on property characteristics and indicators for the transaction quarter. The hedonic price index is constructed as the coefficients on the quarter indicators deflated by U.K. CPI (series D7BT from ONS). Shaded areas show the periods in which the Phillips, Shi, and Yu (2014b) test detects a classic rational bubble at the 5% confidence level (see Appendix A.2.2.2).

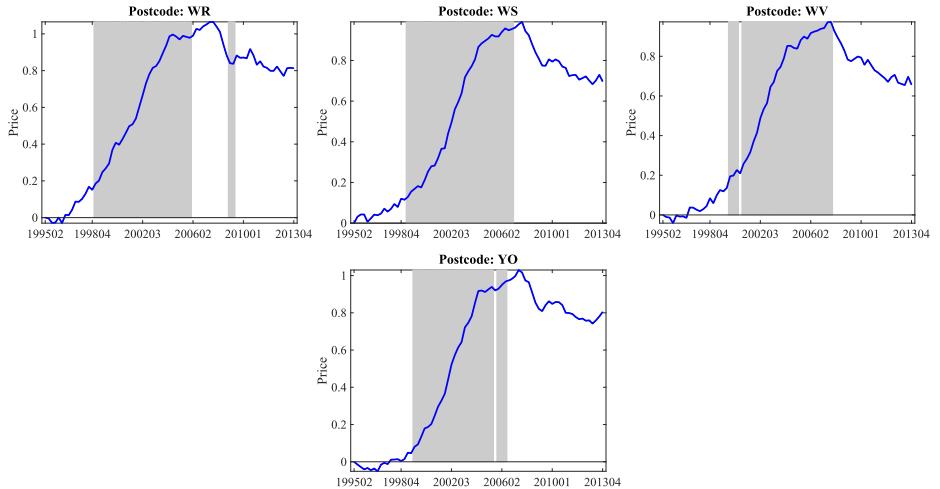


FIGURE A.17.—U.K. postcode areas—house price series. *Note:* Figures show quarterly real log house prices for U.K. postcode areas between 1995 and 2013, obtained by running a hedonic regression of log transaction prices on property characteristics and indicators for the transaction quarter. The hedonic price index is constructed as the coefficients on the quarter indicators deflated by U.K. CPI (series D7BT from ONS). Shaded areas show the periods in which the Phillips, Shi, and Yu (2014b) test detects a classic rational bubble at the 5% confidence level (see Appendix A.2.2.2).

gregate evidence, in all of these regions at least one period with a bubble is identified, typically concentrated around 2002–2004.

A.3. LEASEHOLDS AND FREEHOLDERS: INSTITUTIONAL DETAILS

In this section, we discuss the legal environment regulating the relationship between landlords (freeholders) and tenants (leaseholders) in England and Wales. In this discussion, we draw heavily on the textbook treatments of these issues in [Garner and Frith \(2013\)](#), [Burn, Cartwright, and Cheshire \(2011\)](#), and [Abbey and Richards \(2013\)](#). In most cases, the rights and obligations of a landlord and a leaseholder are fixed by express covenants that are incorporated in the lease. In addition, there are covenants which, although not directly addressed in the leasehold, are part of the contractual agreement by English common law. These are intended to provide a minimum level of protection for both parties. We first focus on the content of these implied obligations, before discussing the express obligations commonly included in leasehold contracts.

A.3.1. *Implied Obligations*

Covenants implied by common law are intended to provide a minimum level of protection for freeholders (landlords) and leaseholders (tenants), even in

the absence of an express agreement in the lease. For the freeholder, implied covenants include the following:

1. *Quiet Enjoyment*—This obligation prohibits the landlord, or any party acting for the landlord, to substantially disturb the enjoyment of the property by the leaseholder for the duration of the lease. In other words, the tenant has the full benefit of the rights of possession for the duration of the lease.

2. *Non-derogation From Grant*—The essence of this obligation, which is closely related to the obligation guaranteeing quiet enjoyment, is the principle that “a grantor, having given a thing with one hand is not to take away the means of enjoying it with the other” (*Birmingham, Dudley and District Banking Co. v Ross (1888) 38 C D at 313*). This prevents the landlord, for example, from erecting a fence that would prevent the tenant from entering the property under contract.

3. *Fitness of Habitation*—In general, there is no requirement for the landlord to ensure that the premises are, or will be, fit for habitation, and no covenant is implied that would require him to carry out repairs. This is based on the principle of *caveat lessee* or “lessee beware,” taken to imply that in the absence of any agreement between the parties, neither side generally is responsible for repairs.¹⁷ We deal with express agreements on repairs below. Some exceptions to this general rule, however, apply to “houses let on low rent.” Section 8(1) of the Landlord and Tenant Act 1985 provides that for houses let at low rent (i.e., below £56 outside London, and below £80 in London), the landlord is required to:

- Ensure that the house is of a condition fit for human habitation at the commencement of the tenancy;
- Ensure that during the course of the tenancy the house will be kept reasonably fit for human habitation.

These minimal requirements hold only for qualifying properties and, even then, only if the lease does not stipulate that it is upon the tenant to put the house in a condition reasonably fit for human habitation. As we discuss below, most leaseholds address the assignment for maintenance responsibilities explicitly.

For a leaseholder, the following covenants are implied by Common Law:

1. *To Pay (Ground) Rent*—In practice, the ground rent is always an explicit part of the contract. We describe in Section A.3.3 that the so-called “ground rents” for houses on extremely-long leaseholds are very small to negligible in magnitude (of the order of £20 per year).

2. *To Pay Taxes*—The leaseholder is required to pay all taxes such as council taxes.

¹⁷For example, *Garner and Frith (2013)* noted that this principle rules out the protection normally afforded to consumers who have recourse toward the seller/manufacturer in case of defective products.

3. *To Allow the Landlord Entry for Required Repairs*—In general, leasehold contracts grant the leaseholder the exclusive possession of the property, including the right to exclude the freeholder. If the freeholder enters without permission, she is trespassing. However, if the landlord is required by the lease to carry out repairs, she is thereby granted the right to enter to carry out such repairs. The landlord is not entitled to carry out improvements or alterations, only repairs.

4. *Not to Deny Landlord's Title*—The tenant is prevented from denying that the landlord has an interest in the land, for example by suggesting that the land is vested in a third party other than the landlord, as this would be tantamount to denying the tenancy altogether; in that case, the landlord is entitled to repossess the property.

5. *To Use the Property in a “Tenant-Like Manner”*—This covenant is not too precisely defined, but is taken to mean that a leaseholder must perform everyday tasks around the house. Denning LJ provided some guidance on this in *Warren v Keen [1954] 1 QB 15 at 20*.

“The tenant must take proper care of the place. He must, if he is going away for the winter, turn off the water and empty the boiler. He must clean the chimneys, where necessary, and also the windows. He must mend the electric light when it fuses. He must unstop the sink when it is blocked by his waste. In short, he must do the little jobs about the place which a reasonable tenant would do. In addition, he must, of course, not damage the house, willfully or negligently; and he must see his family and guests do not damage it: and if they do, he must repair it.”

However, as described above, unless otherwise specified in a covenant,

“[i]f the house falls into disrepair through fair wear and tear or lapse of time, or for any reason not caused by him, the tenant is not liable to repair it.”

As we discuss below, while implied covenants generally do not govern the responsibility for maintenance, it almost always is specified in express covenants of extremely-long leaseholds that it is the responsibility of the lessee to maintain a property.

None of the restrictions implied by Common Law are likely to significantly restrict the valuation of a leasehold property. The law also regulates the process of reversion of the property and land at leasehold expiry to the freeholder. The general principle is that the lease, much like a tenancy, has finite maturity and that at expiry the full enjoyment of the property and land returns to the freeholder. This covers the vast majority of cases; in a minority of cases, the leaseholder is afforded extra protection. The Local Government and Housing Act 1989 provides “security of tenure” to qualifying leaseholders who might otherwise be too adversely affected by the leasehold expiry. The security of tenure provision stipulates that for qualified leaseholders, and in the absence of a court-approved claim for possession by the freeholder, an assured periodic tenancy commences after lease expiration. This tenancy removes all property

rights connected to the leasehold, and obliges the former leaseholder to pay market rent on the property to the landlord going forward.¹⁸

To qualify for this protection, the leasehold must be on the lessee's primary residence, and the lease must have been originally granted for more than 21 years and at low ground rent.¹⁹ In addition, certain properties are excluded from this protection: (i) if the landlord is the Crown, a local authority, a housing association, or charitable housing trust; (ii) if a statutory lease extension (for flats) has been obtained and the extended lease is expiring; (iii) if the property is of high value, as defined in the Act. A landlord seeking to take possession of the property at the end of the lease needs to serve a notice (generally between 6 and 12 months before the lease expiration date) and, even in the case of tenants who are afforded the special protection described above, has several grounds to obtain possession by court order. The most common grounds for possession are that: (i) the landlord wishes to carry out works that cannot be performed with a tenant in place, (ii) equivalent alternative accommodation is available for the tenant to rent at market value in the private property market, (iii) the tenant has not respected some parts of the lease agreement (like paying ground rent and service charges, tenant-induced negligent damage of the property, disturbance of other occupants of the property), or (iv) the landlord wishes to occupy the premises herself or for the use of her immediate family.

A.3.2. Express Obligations

While the covenants implied by Common Law provide a basic minimum standard of protection in case the involved parties fail to specify responsibilities in their contract, most leasehold contracts contain express agreements that regulate the obligations and rights of freeholder and leaseholder in greater detail. In the following, we discuss covenants on the tenant that might affect the value of extremely-long leaseholds relative to freeholds. We argue that none of these requirements have a significant effect on the value of extremely-long leaseholds.

1. Use of Property—The general Common Law rule is that, unless otherwise specified, the tenant might use the property for any lawful purpose; some leasehold contracts therefore stipulate certain prohibitions against changing the use of a particular property. They may, for example, prohibit commercial use, use as a religious meeting house, or use as a brothel. Very often, these covenants pass onto the leaseholder a set of local zoning regulations that also apply to the owners of the freehold. In the following, we provide a number of examples of such covenants that we found in actual leases we inspected manually:

¹⁸Where an agreement between freeholder and tenant cannot be reached on the appropriate market-level rent, the parties can resort to the Rent Assessment Committee to set the rent.

¹⁹Low rent is taken to be “no ground rent payable” or specific low amounts of ground rent payable depending on the start date of the leasehold. See the original Act for more details.

EXAMPLE 1: 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].

(a) 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.

(b) 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.

(c) 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.

EXAMPLE 2: 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 a hotel, public house, or tavern or for the sale of beer wines and spirits.

EXAMPLE 3: 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 2,000 square meters in area.

EXAMPLE 4: Not to use the parking spaces on the Property save for the purpose of parking one private motor vehicle in each space.

EXAMPLE 5: 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.

2. Alterations and Improvements—Leasehold contracts might stipulate that leaseholders have to seek the consent of freeholders before engaging in any substantial changes to the property.²⁰ These restrictions are often in place for a limited period of time only. For example, the following covenant is an alteration restriction from an actual leasehold contract we examined:

²⁰An absolute ban of alterations or additions is uncommon, as highlighted by Burn, Cartwright, and Cheshire (2011), and considered unacceptable in long leases, as described in Abbey and Richards (2013).

Not for a period of two years from the date hereof, without the prior written consent of the transferor, 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.

Notice that the covenant stipulates that consent to any redevelopment shall not be unreasonably withheld. More generally, Section 19(2) of the Landlord and Tenant Act 1927 maintains that no freeholders are allowed to “unreasonably withhold consent” to any redevelopment proposal:

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.

Whether a particular alteration is an improvement is generally determined on a case-by-case basis, but is to be considered from the perspective of the tenant. If, for example, a tenant rents two adjacent shops and wishes to remove a dividing wall to create a larger shop, this would be considered an improvement, even if the letting value from the landlord's point of view would be larger with two separate shops (see *Woolworth & Co v Lambert [1937] Ch 37*).

While the statute does not stop the freeholder from seeking a reasonable sum should the proposed changes diminish the value of the premises, or any adjacent premises of the freeholder, the requirements do not present major obstacles to value-enhancing redevelopment of properties.

In order to reasonably withhold consent, or to receive reimbursement, the freeholder has to show that her claim loses in value as a result of the redevelopment. While this might be relevant in the case of relatively short leases with 10–15 years of remaining maturity, for leaseholds with hundreds of years of remaining maturity the present value of any future loss in value of a freeholder's claim is small to non-existent. This makes withholding consent on improvements in extremely-long leases very hard for freeholders. In addition, if the only loss to the freeholder is pecuniary, she cannot withhold consent reasonably, but is required to grant consent in exchange for reasonable compensation by the leaseholder, based on any demonstrated damage to the value of the premise.

When a leaseholder believes that a freeholder has unreasonably withheld consent to an alteration or improvement, Section 53(1)(b) of the Landlord

and Tenant Act 1954 regulates that the tenant can obtain a declaration from a county court to allow her to carry out the redevelopment in spite of the absence of consent.

On balance, therefore, there are a number of significant protections for leaseholders against being prevented from conducting alterations and improvements to the property. However, whether those are sufficiently powerful to ensure that there are no price discounts for leasehold properties relative to freehold properties is an empirical question. To address that question, in Section 3.3.2 of the paper we exploit cross-sectional differences in the value of redevelopment options, and find the relative pricing of extremely-long leaseholds and freeholds to be identical, even in areas with very high redevelopment potential. This confirms the very small quantitative effect that any restrictions on redevelopment have on the value of extremely-long leaseholds.

3. Sublet of Property— The basic implied principle is that, 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. Therefore, some leases explicitly formalize the scope of the leaseholder's right to sublet the property, that is, to rent it out to somebody else. For example, covenants could be inserted requiring leaseholders to obtain the freeholder's permission to sublet the property. As for many other covenants, any requirements imposed on the leaseholder are severely limited by the general principle that the freeholder cannot "unreasonably withhold" consent to a sublet. Section 19(1) of the Landlord and Tenant Act 1927 stipulates 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

(a) 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

(b) (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.

In addition, the Landlord and Tenant Act 1988 places the burden of showing that any refusal or the imposition of any conditions was reasonable on the landlord. The law explicitly prohibits to refuse to allow permission for subletting the property on grounds of a person's sex, race, religion, sexual orientation, or disability. The Act also gives tenants the right to sue for damages suffered as a result of a landlord's unreasonable refusal.

Sometimes covenants are inserted that allow the freeholder to charge a nominal fee for registering a sublet in order to recover any administrative costs. A number of judicial cases have 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.

Again, as with the restrictions on redevelopment, the requirement to not unreasonably withhold consent to the sublet provides significant protections to the leaseholder's ability to rent out the property. Indeed, if this were not the case, we would expect significant price differences between extremely-long leaseholds and freeholds particularly for flats, which have a much more active rental market than houses. In Section 3.3.2, we show that there is no price difference between extremely-long leaseholds and freeholds for flats, suggesting that restrictions on subletting do not have a significant effect on the valuation of extremely-long leaseholds.

4. *Property Maintenance and Service Charges*—As described in the main body of the paper, there are two common structures for assigning maintenance responsibilities in long-term leases. The simplest one assigns both the responsibility and the financial burden of maintaining the property to the leaseholder. This structure is more common for standalone houses, where there are few common areas to be maintained, and the leaseholder is generally in charge of all aspects of property maintenance. The second structure assigns the responsibility for some activities, such as carrying out repair work, to the freeholder, but then allows the freeholder to recoup the costs from the leaseholder via a service charge. Service charges are payments by the leaseholder for services provided by the landlord. In addition to the cost of maintenance and repairs, these can include charges for the insurance of the building and, in some cases, provision of central heating, lifts, portage, estate staff, lighting, and the cleaning of common areas. This arrangement is more common in flats or multiple housing units, since the presence of common areas and shared exteriors of the building naturally give rise to the need of centralized management.²¹

The Landlord and Tenant Act 1985, s18-30, regulates many of the aspects related to service charges; we provide a brief summary only. Service charges can either be collected as costs arise, or, more commonly, are collected through periodic payments. Any accumulated funds paid by leaseholders are held in a “sinking fund.” There is an obligation on the side of the landlord (Landlord and Tenant Act 1987, s42) to keep the funds in trust, and the contributions of

²¹While data on individual properties' service charges are not available, data from the 2011–2012 English Housing Survey (EHS) show that, on average, only 7.4% of leaseholders living in houses pay a service charge, with the others conducting maintenance and repairs themselves. For leaseholders living in flats, 68% pay a service charge. The average service charge paid by leaseholders living in a house is £681 p.a.; for leaseholders living in flats, the average service charge is £1,282 p.a., presumably because it covers a wider range of services.

the tenants are treated as shares of both the costs of any services, and proportional claims to any unspent funds. Since the sinking funds can at times contain substantial sums (e.g., just before the beginning of major works), the Landlord and Tenant Act 1987, s42, places strict burdens on the landlord, who has to communicate to tenants a designated bank account at a qualifying financial institution and present timely balances and expense reports. The landlord is criminally liable for failing to comply with these duties.

More generally, the Landlord and Tenant Act 1985 places several restrictions on the freeholder to prevent abuse of the leaseholder:

- *Relevant Costs*: The Act provides a definition of which costs sustained by the landlord can be recovered via the service charge. The general principle is that if the lease does not expressly oblige or allow the landlord to undertake an activity, then its cost cannot be included in the service charge.

- *Reasonable Costs*: The Act stipulates that costs can be charged only “to the extent that they are reasonably incurred and only if the services or works provided are of reasonable standard.” This protects the tenant against landlords that increase costs, through negligence or intent, by overcharging or performing works at a level considered unreasonable (more on this below).

- *Timely Disclosure*: The Act requires the timely disclosure by the landlord of expenses payable under the service charge:

If any of the relevant costs taken into account in determining the amount of any service charge were incurred more than 18 months before a demand for payment of the service charge is served on the tenant, then (subject to subsection (2)), the tenant shall not be liable to pay so much of the service charge as reflects the costs so incurred.

- *Consultation*: When the landlord is proposing expensive works or entering in a long-term agreement with third parties about maintenance of the property, she is required to consult with the tenants. The landlord is required to send an initial notice to each tenant highlighting the planned works and the reasons why the works are necessary, and inviting each tenant to respond to the notice within 30 days. After 30 days, the landlord has to obtain professional estimates (at least one of which has to be from a party unconnected to the landlord) of the costs of the works, and supplies the estimates to the tenants. After a further 30 days, and having considered any tenant responses, the landlord can enter into an agreement to perform the works. If consultation and information requirements are not respected, a tenant may lawfully withhold a service charge payment.

In the event of a dispute between landlord and tenant, the Commonhold and Leasehold Reform Act 2002 stipulates that an application may be made to a Leasehold Valuation Tribunal (now the First-tier Tribunal, Property Chamber) to challenge the reasonableness of a service charge. The Act also 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” (RTM) company. This does not require the landlord’s consent and the leaseholders do not have to show that the current management is at fault, which they

would have to do if they recurred to the tribunal to contest an unreasonable service charge. Having obtained the right to manage the building, the leaseholders are responsible for all functions previously assigned to the freeholder under the lease; they can, of course, delegate such functions to a managing company of their choosing.

5. *Covenants to Insure*—Similar to maintenance works, in some cases the lease requires that the leaseholder insures the property, usually a house, through an insurer nominated or approved by the landlord. For flats, it is more common for the freeholder to arrange the building insurance and then recover the cost via the service charge. The tenant may consider that she can get cheaper insurance from different companies and may be concerned as to the cover provided. The provisions of the Commonhold and Leasehold Reform Act 2002, in addition to determining a disclosure, information, and reasonableness requirement for landlord-provided or designated insurance, also provide in Section 164 the right for the leaseholder to arrange her own insurance, provided she notifies the landlord.

A.3.3. *Ground Rents*

In the U.K., 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 land technically still belongs to the residual freeholder who, in principle, has the right to request that the lessee make regular payments for the use of the land. Ground rents are set separately for each property, and no comprehensive database exists. If such payments significantly affected the value of leaseholds, we would expect those leaseholds to trade at a price discount to freeholds, which would be observationally equivalent to a classic rational bubble. The absence of a price difference between leaseholds and freeholds suggests the quantitative importance of ground rents to be small. Consistent with this, the 2011–2012 English Housing Survey shows that the amounts involved are usually very small (£10–£100 per year), and in many cases are either zero or a symbolic amount (“a peppercorn”). Among those households that report paying ground rents, the median household reported annual rents of about £25. 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. Such requests are often not made, because the amounts collected would be too small to cover the administrative costs.

A.3.4. *Taxation and Stamp Duty*

Purchases of property in the U.K. are subject to a transaction tax (stamp duty land tax, or SDLT). The tax applies equally to freehold and leasehold transactions. The tax schedule is progressive: for example, the purchase of a property

up to £125,000 is tax exempt, while a purchase of a property between £125,001 and £250,000 is taxed at 1% of the total purchase price.²² There are no taxes on the ongoing ownership of a property. Local council taxes are always paid by the inhabitant, independent of whether she lives in a freehold or leasehold property.

Similarly, the purchase of property in Singapore is subject to stamp duty irrespective of the form and duration of ownership. The first SG\$180,000 are assessed at 1%, the next \$180,000 at 2%, and each additional increase in the sale price at 3%. In addition, Singapore also taxes the ongoing ownership of a property, again irrespective of the form of ownership. Property taxes are levied on the Annual Value (AV), the tax-authority assessed one-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\$65,000.²³ As we show in Section 3.1, the rental income, and therefore the Annual Value, of a property is unaffected by the form of ownership.

If a bubble were present, these progressive tax schedules would make leases more attractive, since the leasehold might avoid incurring the higher tax bracket because it does not include the price of the bubble. While this would bias against finding a bubble, the effect is most likely negligible. Only buyers of properties that are very close to the boundaries of the tax bracket would be affected, and since the brackets are relatively large, especially in the U.K., the effect on the average price difference is unlikely to be quantitatively important. Furthermore, under the null hypothesis of our statistical test that there is no classic rational bubble in the data, taxation introduces no bias to our test.

A.3.5. *Bubbles and Finite-Maturity Assets: “No Uncertain Term” Doctrine*

Our test for the presence of classic rational bubbles relies on the maturity difference between extremely-long leaseholds and freeholds. We next document that in both the U.K. and Singapore, extremely-long leaseholds indeed have finite maturity, and distinctly differ in this respect from freeholds.

Both in the U.K. and in Singapore, leaseholds are, by definition, finite-maturity contracts. At expiration, the land and structure revert back to the underlying freeholder. The law is both strict and explicit on the requirement that a valid lease has to be of both *finite* and *determinate* maturity. In the U.K.,

²²In December 2014, SDLT marginal rates were raised, but the higher marginal tax rates were only assessed on the incremental value in the higher tax brackets, not on the entire value. This does not affect the transactions in our sample.

²³Starting from January 1, 2014, property taxes were made more progressive. This does not affect any of the transactions during our sample period.

a remarkably stable judicial principle for the last 500 years holds that a lease with uncertain (potentially infinite) maturity is invalid. Furthermore, if a lease with finite and determinate maturity purports to also grant some rights that are of infinite maturity, then the lease is deemed to be valid only for those terms that have finite and determinate maturity.

The reversion of ownership at lease expiration is enforced by the government. In fact, in both countries a leasehold public record is expunged on expiration from the central title registry, and expired leaseholds have no validity ([Burn, Cartwright, and Cheshire \(2011\)](#)). The government actively tries to inform the public about the finite maturity of leasehold contracts. For example, the Minister for National Development in Singapore, [Gerald Giam \(2014\)](#), stated, when asked about the government's policy toward expired leases: "The value of the flats will be zero at the end of their 99-year lease."

Investors correctly perceive that the leasehold claim to rents has finite maturity. Indeed, the data for shorter maturity leaseholds, which are the focus of [Giglio, Maggiori, and Stroebel \(2015\)](#), show that market participants are aware of leasehold expiration, because the pricing of shorter leases varies significantly with their maturity. For example, even relatively long leaseholds with 300 years of unexpired maturity are priced somewhat below the extremely-long leaseholds and freeholds considered in this paper. Leaseholds with 100 years remaining maturity trade at more than a 10% discount to extremely-long leaseholds. Consistent with this, between 2000 and 2014 an average of 44,674 leaseholds were terminated every year, a process that is formally called "lease determination."²⁴ The maturity of the contract is also a salient characteristic in the marketing process of the properties. Appendix Figures A.18 to A.22 show examples of online property listings in both the U.K. and Singapore; the contract structure and lease length are highly salient aspects of the property description. Similarly, the maturity of the contract features prominently in other marketing materials, such as brochures or store displays.

As highlighted in Section 1.3, our test relies on the theoretical restriction that classic rational bubbles cannot occur on finite-maturity assets, because backward induction rules them out. Having established that the leasehold as a claim to rents has a well-understood and consistently-priced finite maturity, a more subtle theoretical concern is that the leasehold contract could give rise to a continuing claim with positive value even after its expiration as a claim to the rents. One possible concern would be that the actual expired leasehold contract trades for a positive value after expiration of its legal validity as a claim to rent. This leads to the almost philosophical question of whether any contract

²⁴These numbers were obtained through a Freedom of Information Act request to the Land Registry. Numbers are reproduced with the kind permission of the Land Registry, © Crown copyright 2015. No detailed split by method of determination is available. In addition to the expiration of a lease ("effluxion of time"), other reasons for lease determination can include, for example, "determination on merger" and "determination by forfeiture."

3 bedroom apartment for sale
Crown Lane Gardens, London, SW16

Offers in Excess of
£400,000

Start slideshow 1 of 20 Enlarge Picture 2

Do you like this property? Call: 020 8012 3518 Request Details

Description	Floorplan	Map & Schools	Street View	Market Info
Key features <ul style="list-style-type: none"> ■ Three double bedrooms ■ Modern fitted kitchen ■ Contemporary tiled bathroom ■ Private patio garden ■ Close to Streatham Common ■ West Norwood station ■ Private garage ■ Landscaped communal gardens ■ Long lease in excess of 900 years 				
Listing History Added on Rightmove: 11 April 2015				

FIGURE A.18.—Sample property listing in the U.K. *Note:* Figure shows an example of a property listing on [rightmove.co.uk](#).

ever has finite maturity. For example, one could argue that when one buys a 3-month Treasury bill, one buys both the finite-maturity 3-month contract, and the possibility of re-trading (potentially) forever the expired bond certificate,

1 bedroom apartment for sale £565,000
 Langford Court, Abbey Road, St John's Wood, NW8

Start slideshow

1 of 8

Photo 1

Do you like this property? Call: 020 8012 5460 Request Details

Description Map & Schools Street View NEW Market Info

Key features

- Tenure: Leasehold 166 Years
- Service Charge: £2,100 per annum approx.(T.B.C)
- Heating & Hot Water being included in the service charge
- Porter

Listing History

Added on Rightmove:
21 April 2015

FIGURE A.19.—Sample property listing in the U.K. *Note:* Figure shows an example of a property listing on [rightmove.co.uk](#).

as in the actual piece of paper the bond contract is written on. Since this argument could be applied to any possible contract, not just leaseholds or real estate, it would invalidate the idea, and much of the common practice following from it, of the existence of any finite-maturity contract. A second possibility is that the expired contract might be worth zero but that, before expiration, it would give rise to a new (potentially) infinite-maturity contract that the bubble could be rolled into for future re-trading. One concern, for example, could

The screenshot shows the iProperty.com website interface. At the top, there is a banner for 'R&F PRINCESS COVE' featuring a building and the text 'Enjoy a life of convenience in a distinctive environment'. Below the banner is a navigation bar with links: For Sale, For Rent, New Launches, Commercial, Overseas, Loans, Home & Lifestyle, and Expo & More. Underneath the navigation bar is a search bar with fields for '\$ Min', '\$ Max', 'All Bedrooms', 'Landed', and a 'More' dropdown. There are also 'LIST' and 'PHOTO' buttons, and a 'Sort By' dropdown set to 'Featured'.

The main content area displays 'Landed Properties for Sale (3201 Result(s))'. Two properties are listed:

- PALMS Sixth Avenue - Freehold**: SGD 5,453,200. This listing includes a photo of a semi-detached house, the price, agent information (Ivy Yap, HUTTONS ASIA PTE LTD, +659111...), and a 'FEATURED' badge. It also shows a rating of 4 stars and 6 reviews.
- The Whitley Residences- Freehold**: SGD 5,100,000. This listing includes a photo of a modern building, the price, agent information (Ivy Yap, HUTTONS ASIA PTE LTD, +659111...), and a 'FEATURED' badge. It shows a rating of 5 stars and 6 reviews.

FIGURE A.20.—Sample property listing in Singapore. Note: Figure shows an example of a property listing on www.iproperty.com.sg.

be that the statutory ability in the U.K., but not in Singapore, to enfranchise the leasehold by buying out the freeholder leads to this infinite-maturity aspect.

We find that these concerns are not quantitatively relevant for our test. On the concern that expired leases could trade for substantial value, and relatedly that no finite-maturity contract exist, the researchers that developed the theory of rational bubbles provided discipline to their theory, to prevent such arguments from making it an empty philosophical statement. For example, Tirole (1985) remarked on the supply of bubbles that "*I am always willing to pretend that a drawing I made when I was young is worth \$1,000, say. However I doubt I will be successful in convincing others that they should invest in it. [...] There*

The screenshot shows a property listing on the iProperty.com website. At the top, there's a banner for "Phuket condo 1" with a 50% deferred payment offer. Below the banner is a navigation bar with links for "For Sale", "For Rent", "New Launches", "Commercial", "Overseas", "Loans", and "Home & Lifestyle". The main content area has a green header bar with a house icon and the text "CONDODINIUM". The listing is for "Dukes Residences" located at "Duke's Road, 268908 District10". It is a "FOR SALE" property priced at "SGD 3,150,000". The listing details include "SGD 1,989.89 psf (built-in) / 1583 sq. ft. (built-in)" and "Freehold Posted on 21/04/2015". A red box highlights the "Freehold" status and the posting date. Below the listing, there are three tabs: "Photos" (which is selected), "Maps", and "Streetview". A large thumbnail image shows a view from a balcony or terrace over a residential area. Below the thumbnail, it says "2 of 13". At the bottom of the listing, there are five smaller preview images of the interior rooms.

FIGURE A.21.—Sample property listing in Singapore. *Note:* Figure shows an example of a property listing on www.iproperty.com.sg.

are three conditions that are necessary to create a bubble: Durability, scarcity, and common beliefs.” The conjecture that the leaseholds could trade as a pure bubble after the end of any property rights they confer does not satisfy the “common beliefs” or the “scarcity” requirements. The common beliefs requirement fails, because the market for such trading has never existed, nor does it currently exist, nor have we found evidence that market participants expect such

The screenshot shows a property listing on the iProperty.com website. At the top, there's a navigation bar with categories like 'For Sale', 'For Rent', 'New Launches', 'Commercial', 'Overseas', 'Loans', and 'Home & Lifestyle'. A banner on the right says 'VIEW INTERNATIONAL PROPS' and 'PRE-REGISTER AT'. Below the navigation, a breadcrumb trail shows the user has navigated from 'Home' to 'Private Apartments for Sale' to 'District 14' to 'Sims Urban Oasis'. The main listing is for a 'CONDOMINIUM' named 'Sims Urban Oasis' located at 'Sims Drive, District14'. It is listed 'FOR SALE' for 'SGD 811,000'. The listing includes details: 'SGD 1,299.68 psf (built-in) / 624 sq. ft. (built-in)' and '99 Years Posted on 21/04/2015'. A red box highlights the posting date. Below the listing is a large image of the building complex, which consists of several modern residential towers with glass facades. In the foreground, there's a swimming pool area where people are relaxing. The image is labeled '1 of 2' and has a small info icon ('i'). Below the main image are two smaller thumbnail images of the property.

FIGURE A.22.—Sample property listing in Singapore. *Note:* Figure shows an example of a property listing on www.iproperty.com.sg.

a market to exist in the future. For example, Rightmove and Zillow, the two largest online real-estate portals in the U.K., do not feature a single listing for an expired lease. Nor could we find any evidence that such a market exists in

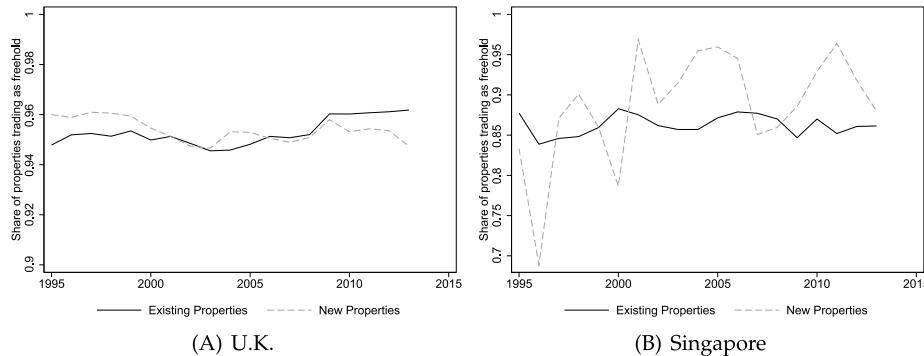


FIGURE A.23.—Time-series of freehold transaction shares. *Note:* Figures show the share of transactions of freeholds in the U.K. (Panel A) and Singapore (Panel B) among the set of transactions of freeholds or leaseholds with more than 700 years remaining. Transaction shares are plotted separately for transactions of new and existing properties. The frequency is annual.

any other outlet.²⁵ Similarly, this theoretical possibility fails the requirement for scarcity. In the reasoning of Tirole, a freeholder could simply generate many leases of very short duration (a day, a month?), because by doing so she would create many bubble claims that could be sold for large amounts of money. Each freeholder's incentive to over-create the bubble will, in equilibrium, destroy the bubble.

The concern that leases confer before or at expiration a continuing claim, a separate and distinct financial claim from the expiring lease, of positive value is ruled out both by the legal doctrine that specifies that no such features of potential uncertain terms can be embedded into a lease (on the penalty of being invalid) and the practice that no such conferred financial claims have ever been observed in the past, or are currently mentioned by market participants. The concern that the bubble could be rolled into either an infinite sequence of lease extensions or the enfranchisement of the leasehold into a freehold cannot explain our results. In the presence of a classic rational bubble, a freeholder that has sold a leasehold on which the hypothetical bubble is attached holds a valuable claim. By selling the freehold to the leaseholder, she would effectively be selling the right of trading the bubble forever, but since it is this potentially infinite re-trading that allows the bubble to exist on the leasehold in the first place, this right is valuable. Our test results of a zero price difference between extremely-long leaseholds and freeholds, and relatively evidence from the courts that enfranchisements do not attach any extra value to the remaining freehold on extremely-long leaseholds, are consistent

²⁵Conversations with market participants, including searches on online real-estate blogs, and inspection of court cases involving disputes among leaseholders and freeholders revealed no indication that participants are expecting such market to exist in the future.

with such an equilibrium only if leaseholders were to obtain the underlying freeholds for sure for free. If the purchases were to happen at market prices, either in or outside of court, extremely-long leaseholds would be less valuable than freeholds.²⁶ We also re-emphasize that this concern is also ruled out by our consistent evidence in Singapore, where enfranchisement is not present as a statutory right and where the SLA, the largest freeholder by far, has made clear that no enfranchisement will be agreed to in bilateral transactions.

Finally, we want to reemphasize that all these concerns do not apply to the freehold contract, which can reasonably have a classic rational bubble attached to it. Freehold contracts are of infinite maturity, have a large and well-understood market that has existed in a stable form for centuries, are durable due to very stable property rights (see Section 3.5), and are clearly scarce, since only one freehold contract can be issued for each property. The bubble on a freehold does not have to trade separately because it can forever trade as part of the valid freehold and be transferred with it among agents.

A.3.5.1. Legal Details on Lease Term

The law is strict and explicit in stipulating that the term, as in the finite maturity of the lease, must be both *explicit* and *certain*. This was highlighted by Lord Templeman in the U.K. House of Lords decision on *Prudential Assurance Co Ltd v London Residuary Body [1991] UKHL 10*:

“My Lords, I consider that the principle in *Lace v Chantler [1944] K.B. 368*, reaffirming 500 years of judicial acceptance of the requirement that a term must be certain, applies to all leases and tenancy agreements.”

The law prohibits uncertain lease terms such as “until such event occurs,” or the possibility of open-ended leases where no specific maturity date is set. This principle invalidates, for example, some leases written during World War II that specified duration as “for the duration of the War.” Such terms were deemed uncertain and, therefore, the leases were declared invalid. Leases that stipulate the maximum duration of the lease to be “for T’s life” or “until T marries,” would be similarly invalid, as these terms are uncertain. More leniency is afforded to setting the start date of a lease, since a lease where a specific start date is not set is assumed to have started immediately. Along these lines, Blackstone, in his Commentaries, 1st ed. (1766), Book II, remarked that:

²⁶Of course, bilateral bargaining between freeholder and leaseholder, or court bias, might not make the leaseholder pay for the entire value of the bubble, but this would at most lead to a quantitative bias, but not induce our finding of a zero price difference. Court settlements are special in many dimensions, including a selected sample, substantial costs, and non-market-driven judicial bias, but in reading their proceedings we never found an instance of the court mentioning the ability of infinite re-trading as a reason why the freehold would be more valuable than the leasehold. For court valuations, see also Badarinza and Ramadorai (2014).

“Every estate which must expire at a period certain and prefixed, by whatever words created, is an estate for years. And therefore this estate is frequently called a term, ‘terminus,’ because its duration or continuance is bounded, limited and determined: for every such estate must have a certain beginning, and certain end.”

This principle is reaffirmed again in The Law of Property Act 1925, which states that:

“The only estates in land which are capable of subsisting or of being conveyed or created at law are—An estate in fee simple absolute in possession; A term of years absolute.”

Here the phrase “an estate in fee simple absolute in possession” is what we refer to as a freehold and the phrase “a term of years absolute” is what we call a leasehold of finite maturity.

Say v Smith (1530) 1 Plowden 269 establishes the principle that if a “lease for a certain term purported to add a term which was uncertain; the lease was held valid only as to the certain term.” This rules out that a lease contract may give rise to any right of uncertain, including infinite, maturity; those rights of infinite maturity would be considered invalid, and the overall lease only valid in as long as it grants other rights with clear finite maturity. In this landmark decision, Judge Anthony Brown J. remarked:

“Every contract sufficient to make a lease for years ought to have certainty in three limitations, viz. in the commencement of the term, in the continuance of it, and in the end of it; so that all these ought to be known at the commencement of the lease, and words in a lease, which don’t make this appear, are but babble. And these three are in effect but one matter, showing the certainty of the time for which the lessee shall have the land, and if any of these fail, it is not a good lease, for then there wants certainty. [...] Every lease for years ought to have a term certain and or determination.”

We conclude this section by reiterating that the law very explicitly makes leases finite-maturity contracts on penalty of being invalid, and that any addendum to a lease that purports to grant potentially infinite maturity is considered invalid. On the contrary, freeholds are infinite-maturity contracts.²⁷

A.4. FURTHER THEORETICAL DETAILS

We next provide further details on the results of Section 1.3.

Leasehold Discounts in a Modern Asset Pricing Model: In the setup of the introduction to the paper, recall that

$$(A.4) \quad P_t = \sum_{s=1}^{\infty} E_t[\xi_{t,t+s} D_{t+s}] + B_t, \quad B_t \equiv \lim_{T \rightarrow \infty} E_t[\xi_{t,t+T} P_{t+T}],$$

²⁷This does not mean that there are no one-off trades of expired leaseholds as rare collectible items, but such a market is, if existent at all, extremely small, and does not fulfill the common beliefs requirement in [Tirole \(1985\)](#).

where $\xi_{t,t+s} \equiv \prod_{j=0}^{s-1} \xi_{t+j,t+j+1}$ and $B_t = E_t[\xi_{t,t+1} B_{t+1}]$. Also recall that for a finite-maturity asset, like the T -maturity leasehold, we have

$$(A.5) \quad P_t^T = \sum_{s=1}^T E_t[\xi_{t,t+s} D_{t+s}].$$

Subtracting (A.5) from (A.4), we obtain

$$(A.6) \quad P_t - P_t^T = \sum_{s=1}^{\infty} E_t[\xi_{t,t+T+s} D_{t+T+s}] + B_t$$

$$(A.7) \quad = \sum_{s=1}^{\infty} E_t[\xi_{t,t+T+s} D_{t+T+s}] + E_t[\xi_{t,t+T} B_{t+T}]$$

$$(A.8) \quad = E_t\left[\xi_{t,t+T}\left[\sum_{s=1}^{\infty} \xi_{t+T,t+T+s} D_{t+T+s} + B_{t+T}\right]\right]$$

$$(A.9) \quad = E_t\left[\xi_{t,t+T} E_{t+T}\left[\sum_{s=1}^{\infty} \xi_{t+T,t+T+s} D_{t+T+s} + B_{t+T}\right]\right]$$

$$(A.10) \quad = E_t[\xi_{t,t+T} P_{t+T}].$$

Equality (A.7) makes use of the recursive nature of the bubble: $B_t = E_t[\xi_{t,t+1} B_{t+1}]$. Equality (A.8) makes use of the recursive definition of the SDF: $\xi_{t,t+s} \equiv \prod_{j=0}^{s-1} \xi_{t+j,t+j+1}$. Equality (A.9) makes use of the law of iterated expectations. Equality (A.10) makes use of the price of the freehold as in Equation (A.4) moved forward T periods. Then, by using Equation (A.10), we have

$$(A.11) \quad \lim_{T \rightarrow \infty} (P_t - P_t^T) = \lim_{T \rightarrow \infty} E_t[\xi_{t,t+T} P_{t+T}] = B_t,$$

where the last equality follows from the definition of the bubble in Equation (A.4). Equation (A.11) is the basis of the empirical test strategy described in Section 1.3.

Discounts in a Gordon Growth Model: Following the classic valuation model of [Gordon \(1962\)](#), we assume that cash flows arising in each future period are discounted at a constant rate r , so that the T -period discount factor is e^{-rT} . Rents grow at a constant rate g , so that they evolve according to $D_{t+s} = D_t e^{gs}$. We consider a deterministic environment only in the interest of simplicity. The price of the T -maturity leasehold, a claim to the rents for T periods, is

$$P_t^T = \int_t^{t+T} e^{-r(s-t)} D_t e^{g(s-t)} ds = \frac{D_t}{r-g} (1 - e^{-(r-g)T}).$$

The price of the freehold, the infinite-maturity claim, is $P_t = \lim_{T \rightarrow \infty} P_t^T = \frac{D_t}{r-g}$, with $r > g$. Notice that we are deriving the fundamental value and hence imposed the no-bubble transversality condition ($B_t = 0$) in taking the limit. The price discount for a T -maturity leasehold with respect to the freehold is

$$(A.12) \quad Disc_t^T \equiv \frac{P_t^T}{P_t} - 1 = -e^{-(r-g)T}.$$

Section 1.3 uses Equation (A.12) above to verify that, under the assumption of no bubbles, maturities (T) in excess of 700 years approximate the infinite limit of the theory well for conventional, and even conservative, choices of net discount rates ($r - g$).

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