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Title: Health impact, process, and economic evaluation of selective licensing schemes for private rented housing in England

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Part A: GENERAL INFORMATION

1. Title

Health impact, process, and economic evaluation of selective licensing schemes for private rented housing in England: Protocol

2. Protocol version

Version	Effective date	Author(s)	Reason for change
1.0	27 Oct 2023	Matt Egan, Jakob Petersen, Alexandros Alexiou, Ben Barr, Frank de Vocht, Katharina Janke, Dalya Marks, Rose McDonald, Maureen Seguin, Roz Spencer, Jill Stewart	N/A
2.0	20 Nov 2023	Matt Egan, Jakob Petersen, Alexandros Alexiou, Ben Barr, Frank de Vocht, Katharina Janke, Dalya Marks, Rose McDonald, Maureen Seguin, Roz Spencer, Jill Stewart	NIHR asked us to address the following: "23. Follow up - please explain why follow up is not applicable. 24. Plan of Study Monitoring - please explain why study monitoring is not applicable." We responded by stating that some follow-up was occurring in WP2 (see page 27), and we provide information on data monitoring (page 28).
2.1	15 Nov 2023	Matt Egan, Jakob Petersen, Alexandros Alexiou, Ben Barr, Frank de Vocht, Katharina Janke, Dalya Marks, Rose McDonald, Maureen Seguin, Roz Spencer, Jill Stewart	Section 18 heading changed from 'Statistical Analysis Plan' to 'Analysis Plan' because it includes analysis plans for all the work packages (including WP2, which is qualitative). Text on outcomes were repeated in sections 18 and 21. Rather than simply repeat the text, we have now summarised the study outcomes in section 21 (section 18 still includes the original full text). Sections 11, 12 and 13 focused originally on only the quantitative sample. We have now added more details of the qualitative sample.
3.0	12 April 2024	Matt Egan, Jakob Petersen, Alexandros Alexiou, Ben Barr, Frank de Vocht, Katharina Janke, Dalya Marks, Rose McDonald, Maureen Seguin, Roz Spencer, Jill Stewart	Jakob Petersen started working at London School of Hygiene and Tropical Medicine in April 2024. We have changed his details to show he is now at LSHTM rather than Queen Mary's University of London. Following comments by our Data Monitoring and Ethics Committee and Independent Steering Committee we have now added a section on supporting data collectors' mental wellbeing. See new section 32.

4.0	11 Mar 2025	Matt Egan, Jakob Petersen, Ben Barr, Katie Fahy, Katharina Janke, Dalya Marks, Rose McDonald, Tanith Rose, Maureen Seguin, Roz Spencer, Jill Stewart, Frank de Vocht	The protocol is aligned with SAP 1.0 (11 Mar 2025) on the following points: 1) Nearly 18% of all standardised LSOA11 intervention unit were fragmented while this was only true for a few units in the feasibility study. By 'fragmented' we mean that the LSOA11 units were only partly exposed to the intervention. This is particularly the case for smaller schemes that have 'bespoke' (rather than administrative) boundaries. SAP now details how this problem is approached in a set of sensitivity analyses weighing up selection bias against measurement error (Section 18. Analysis Plan). 2) At the data extract stage, University of Liverpool recommended focusing on emergency hospital admissions rather than just hospital admissions for the outcome indicators they produce under licence with NHS. The authors agreed to this change by email in July 2024 as this is in line with the literature on preventable hospitalisation (Section 18. Analysis Plan). 3) University of Glasgow (pers. comm., 17 Jun 2024), the owner of the Zoopla rent data, does not recommend combining data from before and after they changed the way they scrape the data from the Zoopla website, referred to as Generations 1 and 2. Consequently, the time series available for analysis is based on Generation 1 data. The first and last full year of data were 2012 and 2018, respectively. Therefore, 2012-2018, will be studied for this outcome instead of 2011-2019 (Section 18. Analysis Plan). 4) Staggered Difference-in-Differences with Propensity Score Matching is the primary evaluation method. Staggered Synthetic Difference-in-Differences (SDID) will now be carried out too. In case the Parallel Trends assumption is violated for a given outcome, SDID will become the primary method instead. We will restrict the analyses to schemes implemented 2012-2019 as the SDID method requires at least 1 year of pre-intervention data (Section 18. Analysis Plan).

			5) Annual precipitation (mm) has been added as a falsification outcome (Section 17. Potential bias). 6) Some outcomes would originally be log-transformed for analysis. We have amended this in line with recent recommendations (Section 18. Analysis Plan). 7) The sample has changed slightly for two reasons, a) we now restrict the analyses to schemes implemented 2012-2019 as the SDID method requires at least 1 pre-intervention time period. Before the sample included three small schemes implemented in 2011: 2011_NewcastleuponTyne, 2011_Stoke-on-Trent, and 2011_Thanet (Section 18. Analysis Plan), b) the SL scheme data have been revised following a data validation consultation (25 Sep-8 Nov 2024): Sheffield 2014 has been recorded as a street-based scheme (N=2 LSOA) and newly treated areas of 2020_Wirral has been recoded as a 'Future treated scheme 2020-21' (N=2 LSOA). 8) In consultation with ISC, we have dropped or simplified some of the secondary subgroup analyses due to multiple testing concerns. False Discovery Rate corrections will furthermore be applied to secondary analyses (Section 18. Analysis Plan). 9) In consultation with DMEC, we have updated the Conflict of Interest statement to reflect that some members reside in local authorities that have or had Selective Licensing schemes.

Standardized Protocol Items: Recommendations for Observational Studies (SPIROS) 2023 Checklist (https://osf.io/59t8r; accessed 03 Nov 2023) was used in writing this protocol.

3. Protocol summary

Plain English summary

The number of people in England who rent their homes from private landlords has increased. The quality of private rented homes is poorer than other housing sectors. Some landlords do not meet all their legal duties. This is worrying, as poor housing is bad for people's health and wellbeing.

Local authorities can choose to implement "Selective Licensing Schemes." These schemes aim to ensure that private rented homes meet required standards. They cover the most common type of private rented housing. Local authorities can choose whether to implement these schemes.

Selective Licensing Schemes involve housing inspections. They require landlords to improve sub-standard homes. They require landlords to take action on anti-social tenants. The government intends the schemes to benefit the wider community. The government states that reducing anti-social behaviour improves well-being.

We need evidence to find out if people benefit from Selective Licensing. This project will provide that evidence for England. We will measure the impact of Selective Licensing on tenants. We will measure impacts on the wider community. These include health, anti-social behaviour and housing impacts. We have identified the data we can use for our statistics.

We will include all the Selective Licensing Schemes in England that have run for at least 5 years. We know where these are. We will compare people who live in these schemes with people who live elsewhere. We have tested our methods in a study of Greater London.

We want to talk to different people and hear their views. We will interview people who implement Selective Licensing Schemes. We will interview landlords, tenants and community groups. For this part of our study, we will select certain schemes and learn more about them. We will look at schemes in the north and south of England. We will cover larger schemes and smaller schemes.

We want to know if Selective Licensing schemes are value for money. We will collect and assess economic information for that purpose.

We want to ensure that our findings are useful and people know about them. We have good links with national and local government. We have good links with relevant charities. We will share our early findings with stakeholders. Their responses will inform our final report.

Scientific abstract (WP1, 3)

Research question

Can selective licensing (SL) schemes improve England's private rented housing sector leading to health and social benefits for residents?

Background

English local authorities can implement SL to help improve conditions and reduce antisocial behaviour (ASB) linked to private rented housing. SL requires private rented landlords to register, purchase a license with various conditions, and allow inspections to ensure housing standards are maintained. A London study of SL found evidence of impacts but a national study is needed.

Study Aim

To evaluate SL schemes for the private rented housing sector in England. The evaluation will assess health and social impacts, implementation and change mechanisms, and economic consequences.

Work package objectives

WP1: To assess individual-level and area-level impacts of SL schemes on health and social outcomes. To assess impacts on equity.

WP3: To assess whether SL schemes are value for money.

Methods

WP1: The proposed impact evaluation uses a difference-in-differences design with matched controls. Individual-level outcomes are self-reported anxiety (primary outcome), wellbeing, general health and residential stability from the Annual Population Survey (APS) and area-level outcomes are

an index of mental health and wellbeing (SAMHI: primary outcome), emergency hospital admissions (all cause, cardiovascular, respiratory, asthma, injuries due to falls or burns), ASB, population turnover and rent.

41 Local Authorities operated 61 SL schemes between 2012 and 2019: n=1,635 Lower Layer Super Output Areas (LSOAs);approx. 5.5% of the English population. For our individual-level outcomes, we estimate that the APS includes around 1000 participants per year from these LSOAs. Over our 2012 to 2019 sample period, we expect to observe around 8,000 individuals in the intervention group and three times as many in the matched comparison LSOAs if we match three control LSOAs to every intervention LSOA. We will estimate the average treatment effect on the treated (ATT) using recently developed difference-in-differences methods for staggered treatment adoption.

WP3: We will conduct a cost-benefit analysis using the subjective wellbeing approach to obtain a monetary value for the benefits of SL.

Timeline and Milestones

Start date: 1st December 2023

Length: 26 months.

- 0-3 months: ethics approval, PPI & AG meetings.
- 2-6 months: WP1 update data, submit protocol
- 7-17 months: WP1 Analysis plan and analysis; WP3 prepare data
- 18-22 months: All WPs: Analysis, interpretive workshops; refine and begin write-up
- 22-26 months: final analysis and write-up.

Key words

Housing system; private rented sector, public health, health equity, natural experiment evaluation.

4. Sponsor and funder detail

Sponsor: London School of Hygiene & Tropical Medicine, Keppel Street, London, WC1E 7HT. +44 (0)20 7636 8636

Funder: National Institute for Health and Care Research, Public Health Research (NIHR PHR 154797)

5. Conflict of interest statements

RS works for Safer Renting, a part of the third sector organisation Cambridge House (https://ch1889.org; accessed 03 Nov 2023), a London based independent charity committed to promoting change that can improve the quality of life and wellbeing of people who are affected by the systemic poverty, social injustice and inequality in our society. ME and JS have recently become advisors to a Safer Renting project aiming at improving the reach of tenant advice to a more diverse range of communities, including those from a wider range of ethnic and religious groups, as well as tenants with disabilities and tenants who experience different (and intersecting) forms of marginalisation. ME is currently conducting a rapid literature review for this project, for which Cambridge House will pay £5000.

DM works part-time at LSHTM and part-time as a Senior Public Health Strategist at Islington Borough Council.

ME and JS are two of the co-chairs of the London Public Health and Housing Network. This is an

unfunded role. The Network links third sector and community stakeholders, local (London) public sector practitioners, national policy stakeholders, Greater London Authority and researchers interested in Public Health and Housing.

The research team includes private rented housing tenants, private rented housing landlords, and owner occupiers. Some members of the team reside in local authorities that have implemented selective licensing schemes.

6. Investigators

6a. Investigator names

Principal investigators: Prof Matt Egan[1] and Dr Jakob Petersen[1].

Co-investigators: Dr Alexandros Alexiou[2], Prof. Ben Barr[2], Dr Katie Fahy[2], Dr Katharina Janke[3], Dr Dalya Marks[1], Ms Rose McDonald[4], Dr Tanith Rose[2], Dr Maureen Seguin[1], Ms Roz Spencer[4], Dr Jill Stewart[5], Prof. Frank De Vocht[6]

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Part B: INTRODUCTION

7. Background, review, and rationale of study

7a. Background of the study

Background

Over four million households in England rent homes from private landlords: 19% of all households in 2019/20 [1]. According to a recent Parliamentary Briefing, the private rented sector (PRS) 'has the worst housing conditions' compared to owner occupied and social rented sectors [2]. Housing quality improved between 2000 and 2019 across all sectors but continued to be relatively worse for PRS [1]. The proportion of homes failing to meet the criteria of the Decent Homes Standard in 2019

was 23% in PRS compared to just 12% in the social rented sector and 16% for owner occupied homes. The proportion of households occupied by private renters doubled from 2000 to 2017/18 before declining slightly to its current level. Hence, relative to the other main housing sectors, the PRS is a priority because it is a poorly performing, poor quality source of housing that England's population has become increasingly reliant on this century.

The cost of poor housing to the NHS has been estimated at £1.4billion [3]. Health problems caused or exacerbated by PRS housing are estimated by government to cost the NHS £340 million a year [4]. Furthermore, national government has recently stated that "a fifth of PRS tenants in England are spending a third of their income on housing that is non-decent" [4]. It goes on to say that the most serious hazards "exist in 12% of properties, posing an immediate risk to tenants' health and safety" and an estimated 1.6 million PRS tenants live in dangerously low-quality homes [4]. According to the government, private landlords who rent out non-decent properties receive an estimated £3 billion from the state in housing welfare. While some PRS homes cater for affluent tenants, many tenants are people who cannot afford to buy and have been unable to get social housing – including a large number of housing benefit recipients. Over a third of PRS households include children [1]. Improving the PRS therefore has the potential to reduce inequity and improve the lives, health and wellbeing for a large section of England's population experiencing housing disadvantage.

Poor regulation of the PRS also affects the wider community. The government has stated the view that poorly regulated properties are associated with area decline and anti-social behaviour. This view was re-stated in the Department for Levelling Up, Housing & Communities (DLUHC) 2022 White Paper, 'A Fairer Private Rented Sector' [4], and in recently updated government guidance on landlord licensing [5]. Besides concern about quality of housing, the PRS has also been criticised for the ease and regularity that tenants are evicted, often without justification or fault on the tenants' side (e.g. if a landlord decides to sell up or raise rents). PRS tenants' security of tenure is therefore 'precarious' [6], with potential implications for mental wellbeing, as well as disruptions to lives and access to local services.

Sometimes, concerns about the PRS focus on so-called 'rogue landlords' [7] – landlords responsible for extreme cases of exploitation, criminal behaviour and the very poorest housing conditions. In this study, we assume that the PRS requires improvements that go well beyond a small minority of the very worst offenders (indeed, those worst offenders may require specific measures that differ from, or work in addition to, the intervention we propose to evaluate). The government's figures referred to earlier support the view that problems with the PRS are widespread. They affect a large minority of private sector homes, suggesting systemic failings across much of the sector that need to be addressed. Systemic failings may reflect both ineffective regulation and under-regulation of the PRS, as well as non-compliance by many landlords who are unable or unwilling to adhere to regulations that are in place [8].

Intervention

This research protocol focuses on one type of regulatory intervention that local authorities have discretion to implement or not implement. The Housing Act 2004, and subsequent revisions in 2015, gave local authorities discretionary powers to implement **selective licensing (SL)** schemes [5]. SL requires landlords in geographically defined areas to pay for a 5-year licence. Fees vary but are around £600 [9,10]. The fees help finance the local authority's regulation of PRS in that area (e.g. housing inspections) although they may not cover the full costs to local authorities. When local authorities inspect PRS homes and find them to be substandard, landlords are expected to pay for the improvements necessary to meet the legal standards.

SL applies to privately rented properties occupied by a single household. Nine out of ten PRS homes meet this description. Houses that include multiple households (Houses in Multiple Occupation or HMOs) are not covered by SL. HMOs have separate license schemes not covered by this study.

Local authorities must obtain approval from national government if a proposed SL scheme covers >20% of their geographical area or affects >20% of privately rented homes in the local authority area. In this study, we will call these 'larger' SL schemes. SL schemes covering up to 20% can be implemented by local authorities without applying for this national government approval. We will call these 'smaller' SL schemes. The smaller schemes therefore have a simpler approval mechanism and they occur most frequently as zoned sub-areas within local authority boundaries.

Importance

Housing is a social determinant of health [11]. Poor quality homes present numerous environmental risks to residents' health, including risks of injury, physical illnesses linked to cold, damp, and indoor air pollution, and risks to mental health and wellbeing [12]. As stated earlier, the cost to the NHS is high. The unequal distribution of poor-quality homes correlates with other social inequalities in health [13].

Housing improvement interventions have been shown to benefit residents' health, including mental health and wellbeing, and respiratory health and injury rates particularly when targeted at those most in need [12,14–17]. Strategies and recommendations for promoting health equity often include housing improvement [11,18].

While simple(ish) mechanisms for improving tenants' health can be hypothesised (housing improvement and greater scrutiny of landlords), SL is intended to improve area-level outcomes for the wider community [19,20]. SL is not just about refurbishment. It is also about connecting landlords more with local government regulators and addressing what government perceives to be a contributor to area decline and anti-social behaviour. SL was justified by national government as a means of tackling "unprofessional landlords," who "show no interest in managing their properties properly, often letting to anti-social tenants who cause a range of problems. This, in turn, can create misery for the local community and cause further destabilisation of these areas" [19,20]. The most recent SL guidance states, SL "can contribute to an improvement in the well-being of the occupants and wider community" [21].

Interventions such as SL that attempt to identify landlords and strengthen landlords' connection with local government regulators could potentially help address systemic problems with the PRS. They might also face barriers linked to a pre-existing culture of non-compliance amongst landlords exacerbated by (in some cases) a lack of resource, poor knowledge of the regulatory environment and at times even a failure to self-identify as landlords running an important service-sector business with legal obligations [8,22].

As SL is currently being implemented in local authorities across England, it is important to assess their impacts and test the policy assumptions underpinning SL – including assumptions about wider impacts and impacts on anti-social behaviour, as well as potential health and wellbeing impacts and unintended consequences.

7b. Review of prior research

There are relatively few experimental and long-running studies of the impacts of housing interventions on health due to challenges with such research [12,17,23]. The evidence mainly comes from observational, and often short-term, studies [15,17], with only rare examples of randomised designs [24]. In the UK, natural experiment designs have been used to assess impacts of housing interventions – often linked to urban regeneration [13]. A systematic review of the effect of housing improvement on health outcomes published in 2013 found the clearest evidence for interventions that provide thermal comfort [17]. Being able to heat the home economically had impacts on health outcomes (general health, mental health, respiratory health, reduced absences from work and school) as well as facilitating better use of indoor space for the residents. In 2019, a systematic

review found, in addition to heating, health benefits from improved ventilation, improved water supply, and removal of indoor hazards [12].

PRS interventions have received less attention in the literature. One recent review found evidence that health and wellbeing are at particular risk in PRS, although the evidence base for interventions that might improve the sector was poor [8,25]. A review of Housing and Health Inequalities in London from the Institute of Health Equity included amongst their recommendations (many of which focused on social housing) support for licensing of PRS properties to fund enforcement of standards in that sector. The authors also recognised the lack of evidence on the effects of PRS licensing but did note our own (at that time unpublished) work on SL in London.

A recent study using a survey to explore PRS landlord views and behaviour in the UK found only 55% of landlords considered laws and regulations on minimum property standards when assessing the quality or condition of a property [26]. Many landlords also used agents and property management organisations to help manage tenancies, but many landlords believed the quality of such organisations varied and some expressed incorrect beliefs about how using such organisations removed their own legal responsibilities as landlords. The authors concluded that many landlords had negative attitudes towards the law, an informal approach to renting, poor financial management, and misplaced assumptions about their responsibilities [26].

In 2019, UK government published an independent evidence review of selective licensing, which focused primarily on barriers and facilitators to implementation [9]. We have also searched the literature on health outcomes for housing interventions in PRS. We identified 24 studies, around a third of which focused specifically on selective licensing. These were small-scale evaluations with some useful qualitative findings on implementers' views. There was much less evidence on tenant and landlord views, and no robust quantitative evaluation of the impacts (including health, social and economic impacts) of SL, except for our own recently published evaluation. Our own London study is, to our knowledge, the first and only impact evaluation of SL in the available literature.

Our previous study piloted methods and access to data relevant to this study and found our approach feasible. We found reductions (i.e. improvements) in Small Area Mental Health Index (SAMHI) scores; reductions in police-recorded ASB; and increases in population turnover. The findings are promising but focus on impacts within London's unique housing context. Furthermore, sensitivity analysis revealed that the impacts on SAMHI were driven by changes that occurred in London's largest SL, which was also the main setting for the 2012 London Olympics. The ASB and population turnover impacts remained significant even after we omitted this scheme from the analysis. We also found that although SL schemes have 5-year cycles, impacts began to occur from years 3 to 4. If SL schemes can have important impacts prior to completion, this suggests that the schemes may still be impactful even if they achieve only partial compliance and partial completion. It is important to test if these and other impacts occur at the national level.

From our assessment of pre-existing literature on SL, we conclude the following. There is little of it. It primarily focuses on implementation. To date, we have produced the only controlled impact evaluation of SL with our London study. There is a need for a national evaluation that focuses on health and social impacts, equity, economic evaluation, and includes tenant and landlord views. We recognise that existing evidence does cover implementers' views on barriers and facilitators, although we would argue that it still makes sense to include some focus on implementer views within our proposed study. We cannot randomise this intervention and so propose a Difference-in-Difference (DiD) natural experiment study with matched controls. We should examine both area-level impacts and impacts on exposed PRS tenants, in so far as the available data allow.

7c. Rationale of study

Theory of change

SL schemes are justified by central government as both potentially beneficial to PRS tenants and to the wider population in localities where the scheme is implemented. Furthermore, all local authorities implementing SL must provide a specific justification for their own scheme from a set list. A government commissioned *Independent Review of the Use and Effectiveness of Selective Licensing* (2019) [9] found that poor condition of housing and anti-social behaviour (ASB) were the most commonly cited local reasons for implementing SL (each justification was used for approximately a third of SLs). Other, less frequently cited justifications included deprivation, low housing demand, crime and issues related to migrant communities. While these justifications might be assumed to give some indication of a local authority's (stated) priorities, they are not limiting. Local authorities can use SL to tackle multiple issues of importance to them. For example, our London study found that the licenses issued to landlords had numerous conditions about preventing and responding to ASB, even when the relevant scheme had a different stated justification.

SL is a complex intervention situated within a multi-level complex system that includes tenants, properties, local and neighbouring areas and communities, landlords, property managers, other service-providers, housing markets, and local and national government. A characteristic of some complex systems is that benefits in one part of the system may contribute to harms or problematic outcomes elsewhere in the system. We hypothesise that this applies to the housing system. Some of these unintended consequences can be hypothesised in advance, while others may take us by surprise. What follows is a list of hypothesised unintended consequences we have thought about (we have given each a name, in capitals).

1. POLICY PRIORITY HYPOTHESIS. Some have argued that England's PRS is fundamentally flawed and that people are likely better off (and healthier) owning/mortgaging a home or using social housing [25]. An implication of this argument might be that even if SL does improve the PRS, it risks diverting policymakers away from policies to improve equitable access to the other sectors (e.g. through more affordable ways to buy, and more social housing).
2. AREA IMPROVEMENT HYPOTHESIS. If a place/locality improves, or is widely perceived to have improved, property values could increase. As a result, higher property prices would displace residents who cannot afford those prices.
3. HOME IMPROVEMENT HYPOTHESIS. If individual homes are improved, landlords may want to raise rents to reflect higher market values of improved properties.
4. PASSING COSTS ON TO TENANTS HYPOTHESIS. Landlords may raise rents to cover the costs of any mandated refurbishment and/or the license fee itself.
5. STOP RENTING HYPOTHESIS. Landlords may choose to stop renting property rather than pay for a license or improvements. Taking non-decent homes and poor landlords out of the PRS may be necessary for the sector's improvement but tenants could lose their home.
6. ASB DISCRIMINATION HYPOTHESIS. License conditions that oblige landlords to prevent and reduce ASB may be acted upon in ways that discriminate against certain groups.
7. ASB DISPLACEMENT HYPOTHESIS. Attempts to tackle ASB may displace rather than genuinely reduce ASB if antisocial tenants are obliged to live elsewhere.
8. POLARISATION HYPOTHESIS. Non-compliant landlords may be more likely to let to disadvantaged tenants, who have fewer housing options.

Furthermore, we hypothesise a number of barriers in our proposed pathways to impact (See logic model). For example:

9. NON-COMPLIANCE HYPOTHESIS. Intervention effects may be reduced due to landlord non-compliance at any stage on the pathway to impact (e.g. applying and paying for licenses,

meeting conditions of licenses, co-operating with the inspection regime, and refurbishing sub-standard properties).

10. PARTIAL IMPLEMENTATION HYPOTHESIS. Implementers may lack resource (e.g. finance, workforce) or face other barriers that prevent full implementation.
11. LOCAL VARIATION HYPOTHESIS. Local variation in the implementation of SL may lead to local variation in impacts. Local variation can at times be considered positively (e.g. tailoring to local needs) or negatively (e.g. inequities / 'post-code lottery').

WP1 and WP3 include quantitative analyses to identify potentially detrimental effects and (in)equity, while WP2 will use qualitative methods to explore unintended consequences, as well as barriers and facilitators to planned/desired impacts.

We note that we have found it difficult to represent all of these hypotheses diagrammatically in the logic model – we found a mixture of text (ie. above) and diagram easier to work with.

8. Aims and objectives

8a. Aim

To evaluate SL schemes for the private rented housing sector in England. The evaluation will assess health and social impacts, implementation and change mechanisms, and economic consequences.

8b. Objectives

WP1: To assess area and individual level impacts of SL schemes on health and social outcomes. To assess impacts on equity.

WP2: To assess SL in terms of the following (i) stakeholder acceptability (ii) pathways to impact, (iii) unintended and systemic consequences; (iv) barriers/facilitators; (v) equity assessment.

WP3: To assess whether SL schemes are value for money.

WP4: To share and interpret findings with stakeholders.

Research Question

Can selective licensing (SL) schemes improve England's private rented housing sector leading to health and social benefits for residents?

PICO

- Population: Residents in areas exposed to SL; Individual PRS tenants exposed to SL. (For qualitative work, relevant stakeholders we will sample include tenants, landlords, implementers and service providers).
- Intervention: SL schemes.
- Control: Matched control areas.
- Outcomes:
    - Area level: mental health and wellbeing (SAMHI: primary outcome); physical health (operationalised as all-cause emergency hospital admissions, cardiovascular emergency admission in 65+yr, respiratory emergency admission in 65+yr, emergency admission injuries falls/burns in 65+yr (any place of occurrence), asthma emergency admission (all ages, 65+yr), all-cause A&E attendance (all ages, 0-14yr, 65+yr)); ASB, population turnover, £ rent.
    - Individual level: self-reported anxiety (primary outcome); general self-reported health, residential stability (ONS Annual Population Survey - APS).

8c. Purpose

Mixed-methods evaluation of impacts and processes. The impact assessment intends to estimate causal effects.

Part C: METHODS

9. Design and setting of study

9a. Study design

WP1 Impact evaluation: Individual-level outcomes

The impact evaluation has a difference-in-differences design with matched controls. The idea of a difference-in-differences design is to supplement a simple before-after comparison of the outcomes of interest in the treated units with a before-after comparison of the outcomes in a set of control units to remove any changes that would have happened in the absence of the intervention. The underlying assumptions is that in the absence of the intervention the average before-after change would have been the same in the treated units and in the control units, known as the parallel trends assumption.

When considering individual-level outcomes, treated units are private rented sector tenants in LSOAs with SL. Potential control units are individuals who do not live in private rented sector housing or who do not live in LSOA with SL. However, SL might have spillover effects. For example, many SL schemes are set up to tackle anti-social behaviour. If they were effective at addressing anti-social behaviour, individuals in SL areas who do not live in private rented housing might also benefit from SL. Using these individuals as controls might therefore result in underestimating the impact of SL. Similarly, individuals in neighbouring LSOAs who do not have an SL scheme in place might be affected by the SL scheme if, for example, SL leads to displacement of certain types of private sector tenants such as tenants engaged in anti-social behaviour. Using these individuals as controls might result in overestimating the impact of SL.

We therefore use as our controls individuals who live in private rented housing in LSOAs without SL that are not direct neighbours of LSOAs with SL. From among these controls, we choose those individuals who live in LSOAs that we have matched to the treated LSOAs using characteristics of the LSOAs such as proportion of individuals who are under 16, proportion of individuals who are non-white and proportion of households classed as overcrowded.

Our individual-level outcome measures come from repeated cross-sectional data, so each year different individuals are being observed in each LSOA. The starting point for our analysis is the canonical two-way fixed effects regression specification:

$$Y_{iat} = \alpha_a + \varphi_t + \beta D_{at} + \varepsilon_{iat}$$

Y_{iat} indicates one of our outcome measures for individual *i* in LSOA *a* in year *t*. α_a is an LSOA effect, which accounts for time-invariant differences between the LSOAs, and φ_t is a year effect, which accounts for changes over time happening in all LSOAs. D_{at} takes the value 1 if LSOA *a* is subject to an SL scheme in year *t* and 0 otherwise. β is the treatment effect, i.e. it captures the impact of the SL scheme. In the special case of only two years *t* (before and after the intervention) the ordinary least squares (OLS) estimate $\hat{\beta}$ is equivalent to the difference-in-differences estimate $\hat{\gamma}$:

$$\hat{\gamma} = \left(\bar{Y}_{SL,AFTER} - \bar{Y}_{SL,BEFORE}\right) - \left(\bar{Y}_{COMPARATOR,AFTER} - \bar{Y}_{COMPARATOR,BEFORE}\right)$$

$\bar{Y}_{SL,AFTER}$ is the mean of the outcome measure in the LSOAs with an SL scheme after implementation of the SL scheme and $\bar{Y}_{SL,BEFORE}$ is the mean before implementation. $\bar{Y}_{COMPARATOR,AFTER}$ is the mean of the outcome measure in the matched comparator LSOAs in the year after SL was implemented in the SL areas and $\bar{Y}_{COMPARATOR,BEFORE}$ is the mean in the year before implementation. Unfortunately, this intuitive causal interpretation of the parameter estimate $\hat{\beta}$ is unlikely to apply in the more general case of more than two years *t* and the intervention being rolled out over several years. As the implementation of SL schemes is at the discretion of local authorities, they have been rolled out at different times over many years.

In this setting with staggered intervention timing the OLS estimator of β in the canonical two-way fixed effects regression yields an unbiased estimate of the treatment effect only if there is no treatment effect heterogeneity, i.e. if all LSOAs have the same treatment effect and if the treatment has the same effect regardless of how long it has been since the treatment started. The bias occurs because the OLS estimator is a weighted average of comparisons between treated and not-yet-treated units as well as between treated and already-treated units. If, for example, the treatment effect gets stronger over time, the parallel trends assumption discussed above does not hold for the latter comparison [27,28].

The recent literature on difference-in-differences has proposed alternative estimators that overcome the problem of the "forbidden" comparison between treated and already-treated units by making transparent exactly which units are being used as comparison [29]. We will apply the Callaway and Sant'Anna estimator as our main method [30]. This estimator allows for arbitrary treatment effect heterogeneity and dynamic effects by deconstructing the estimation of the overall treatment effect into estimation of so-called group-time average treatment effects. We will apply different aggregation schemes to explore the overall effect as well as treatment effect heterogeneity over time and across groups.

To assess the plausibility of the parallel trends assumption, we will examine the trends in the outcome measures for the treatment and control units in the before period by plotting the raw data over calendar time for the treatment and control units, with the treatment units and their matched control units.We will test if the estimated treatment effects for the three years before the intervention are jointly statistically significantly different from zero. Recent reviews discuss the difficulties with formally testing parallel trends as the analysis may be underpowered [29,31]. Analysts are advised to also assess event time plots and to exercise a degree of pragmatism in cases of small deviations from no-effect before the intervention.

If the parallel trends assumption seems implausible, we will use Synthetic Difference-in-Differences (SDID) instead of DiD as the primary method [32,33]. If the parallel trend assumption is plausible, we will use SDID for our primary outcome to assess the sensitivity of our results to the specific method. SDID finds controls matched on the pre-intervention evolution of outcomes through a weighting strategy and thereby ensures parallel trends in the pre-intervention period. Simulations have shown that SDID performs well compared to other commonly used methods [34]. We will use the same set of LSOA-level covariates for the synthetic controls as for the propensity score matching (see Table 4).

We will explore spillover effects by repeating the difference-in-differences analysis with matching for (1) individuals who do not live in private rented sector housing and (2) for individuals who live in LSOAs that are first-order neighbours of SL areas. For (1) we will compare individuals who do not live in private rented sector housing in SL areas to individuals who do not live in private rented sector housing in the control areas that we have matched to treatment areas for the main analysis. For (2) we will treat the first-order neighbours of treated LSOAs as if they are intervention LSOAs and match

them to comparable LSOAs that are neither SL areas nor SL area neighbours. We will report the average effects over the first five years after the intervention (0 to 5 years) as the main result. We will report this together with an event time plot showing all available years before and after the interventions. In addition, we will report delayed effects and longer-term effects as secondary results.

WP1 Impact evaluation: Area-level outcomes

When considering area-level outcomes, treated units are LSOAs with SL. Potential control units are LSOAs without LSOA. However, SL might have spillover effects. Neighbouring LSOAs who do not have an SL scheme in place might be affected by the SL scheme if, for example, SL leads to displacement of certain types of private sector tenants such as tenants engaged in anti-social behaviour. Using these LSOAs as controls might result in overestimating the impact of SL. We therefore use as our potential controls LSOAs without SL that are not direct neighbours of LSOAs with SL. From among these potential controls, we choose LSOAs that we have matched to the treated LSOAs using characteristics of the LSOAs such as proportion of individuals who are under 16, proportion of individuals who are non-white and proportion of households classed as overcrowded.

The starting point for our analysis of the area-level outcomes is the following two-way fixed effects regression specification:

$$Y_{at} = \alpha_a + \varphi_t + \beta D_{at} + \varepsilon_{at}$$

Y_{at} indicates one of our outcome measures for LSOA a in year t. α_a is an LSOA effect, which accounts for time-invariant differences between the LSOAs, and φ_t is a year effect, which accounts for changes over time happening in all LSOAs. D_{at} takes the value 1 if LSOA a is subject to an SL scheme in year t and 0 otherwise. β is the treatment effect, i.e. it captures the impact of the SL scheme. Because of the staggered intervention timing we will apply the Callaway and Sant'Anna estimator and estimate all relevant group-time average treatment effects and then summarise them using different aggregation schemes [30].

As for the individual-level outcomes, we will assess the plausibility of the parallel trends assumption by examining the trends in the outcome measures for the treatment and control units in the before period by plotting the raw data and by running an event study regression for each group. In case the parallel trends assumption is implausible, we will use Synthetic Difference-in-Differences (SDID) instead of DiD as the primary method [32,33].

We will explore spillover effects by repeating the difference-in-differences analysis with matching for LSOAs that are first-order neighbours of SL areas by treating the first-order neighbours of treated LSOAs as if they are intervention LSOAs and matching them to comparable LSOAs that are neither SL areas nor SL area neighbours.

WP2 Process evaluation

The process evaluation will be qualitative semi-structured interviews with stakeholders (tenants, landlords, implementers and representatives of stakeholder organisations); a national and a local workshop; document analysis.

WP3 Cost-benefit analysis using subjective wellbeing approach

The economic evaluation will produce a cost-benefit analysis that uses the subjective wellbeing approach to monetise the benefits of SL. The starting point for the calculation of the benefits of SL will be the estimate of the impact of SL on the life satisfaction variable from the APS, one of our individual-level outcome measures. We will then follow the procedure described in Dolan et al. (2019) [35].

Essentially, we will use an estimate of the impact of income on life satisfaction from previous research to determine the income change that would be required to achieve the same change in life satisfaction as achieved by SL. Multiplying this income change amount by the number of individuals affected by SL will provide the total benefit of SL from a societal perspectives. All our calculations will be retrospective and estimate the benefits of SL over our 2012 to 2019 sample period. Depending on the results of our analysis of spillover effects, we will adjust the benefit estimate accordingly.

We will calculate the costs of SL from a public sector perspective and attempt to estimate the costs of SL from a societal perspective. To determine the total cost of SL from a public sector perspective over the 2012 to 2019 sample period, we will measure the direct and indirect cost of SL in four case study sites. Accounting data provided by the case study sites will be the starting point for the cost calculation. However, the economic concept of opportunity cost goes beyond accounting cost. For example, local authorities might employ staff specifically for the administration of the SL schemes in their area, so these costs would be included in the accounting data as staff salaries and on-costs. However, staff not specifically employed for SL purposes might also be involved in administering local schemes. Any staff involved in SL will require office space and might need to be trained and supervised. Local authorities need to disseminate information about their SL schemes using their website or other means and maintain the online application system. All these activities incur costs, either directly in the form of money being handed over in payment or indirectly in the form of resources such as staff time or office space not being available for alternative uses.

The four case study sites have been selected to represent different types of SL (smaller and larger) in different regional contexts (north and south). We will use extrapolation methods that use these two broad characteristics as well as cost information obtained through FOI requests to assign costs to the other local authorities that have implemented SL. We will subtract income from license fees, fines and civil penalties to obtain net costs.

In addition, we will estimate the potential costs saved by the NHS through SL's impact on antidepressant prescribing, mental-health related hospital admissions and all-cause hospital admissions over our sample period. If possible, we will also estimate potential cost savings through impacts on mental health-related benefits. If we find substantial cost savings, we will subtract these from the cost of SL to local authorities to obtain net costs from a public sector perspective.

To estimate net costs from a societal perspective we will add back in any income local authorities generate from license fees, fines and civil penalties and try to estimate the costs landlords incur to remove hazards following the receipt of an improvement notice issued by the local authority following an SL inspection.

WP4: Knowledge exchange

Knowledge exchange workshops with our policy and practice links, including charities (Shelter, Crisis, Safer Renting), national government, local and regional government, practice and research networks.

9b. Study setting

WP1 and WP3 will examine impacts across England.

WP2 will include studies of four sites where local authorities have implemented SL schemes. Two in the north of England and two in the south of England: including a larger and smaller scheme in the north and also in the south. Liverpool (larger scheme, north), Gateshead (smaller scheme, north), Newham (larger scheme, south), and Islington (smaller scheme, south) local authorities have expressed interest in taking part.

10. Study schedule

Start date: 1st December 2023 (see Gantt chart, Fig. 3, Appendix I)

Length: 26 months.

- 0-3 months: ethics approval, PPI & AG meetings.
- 2-6 months: WP1 update data, submit protocol; WP2 begin recruitment and data collection.
- 7-17 months: WP1 Analysis plan and analysis; WP2 data collection; WP3 prepare data
- 18-22 months: All WPs: Analysis, interpretive workshops; refine and begin write-up
- 22-26 months: final analysis and write-up.

11. Sample size

Individual-level outcomes

For the individual-level outcome measures, we estimate that the APS includes about 1,000 respondents per year who live in private rented accommodation in LSOAs covered by SL schemes, so over our 2012 to 2019 sample period we expect to observe around 8,000 individuals in the intervention group (5.5% of the England population live in the schemes included in the study). The number of APS participants in the matched comparison LSOAs will be approximately 3000 per year if we match 3 control LSOAs to every intervention LSOA.

As the power calculation for our staggered treatment timing difference-in-differences design with repeated cross-section data would be very complicated, we ran a power calculation for the canonical difference-in-difference design with one pre- and one post-intervention observation to get a broad idea of the statistical power of our analysis. The power calculations are based on a bootstrapping algorithm with 1,000 repetitions with 95% significance level and a 3:1 ratio between control to intervention units. The outcome variable was designed as normal-distributed and z-standardised in an artificial dataset. With just 1,000 respondents – the potential annual number of respondents in treated areas – the minimum detectable difference would be 30% of an SD (Table 1).

Table 1 Power calculations based on bootstrapping algorithm with 1,000 repetitions for a DiD design with 95% significance level, one pre- and one post-intervention observation, and 3:1 ratio between control to intervention units (Burlig et al. 2020) [36]. The outcome variable was designed as normal-distributed and z-standardised. Cells shaded in grey indicate power calculations at or above 80%. A unit can correspond to either a respondent or a LSOA area depending on the context. N corresponds to the number of treated units.

N	10%SD	15%SD	20%SD	25%SD	30%SD
1000	0.167	0.291	0.523	0.694	0.837
1500	0.195	0.440	0.637	0.864	0.953
2000	0.272	0.540	0.800	0.934	0.989
2500	0.333	0.659	0.884	0.972	0.997
3000	0.379	0.706	0.923	0.987	0.998
3500	0.423	0.787	0.958	0.989	1.000
4000	0.515	0.833	0.979	0.997	1.000
4500	0.568	0.876	0.988	0.999	1.000
5000	0.593	0.894	0.993	0.998	1.000
5500	0.652	0.930	0.993	1.000	1.000
6000	0.685	0.946	1.000	1.000	1.000
6500	0.727	0.962	0.998	1.000	1.000
7000	0.767	0.973	1.000	1.000	1.000
7500	0.755	0.982	1.000	1.000	1.000
8000	0.797	0.986	1.000	1.000	1.000
8500	0.811	0.992	1.000	1.000	1.000

9000	0.839	0.994	1.000	1.000	1.000
9500	0.850	0.994	1.000	1.000	1.000
10000	0.870	0.999	1.000	1.000	1.000

Area-level outcomes

For the area-level outcomes, our main analysis will examine 1,635 treated LSOAs, which would give a minimum detectable difference of 25% of an SD (Table 1).

12. Sampling procedure

For our impact and economic evaluations, our intervention group will include all selective licensing schemes operating in England after 2012, as identified by Freedom of Information (FOI) requests to all English local authorities. Comparison areas will be identified through matching (see Section 18).

The qualitative sample for work package 2 is designed to include a diverse range of stakeholders and tenants. We agreed a lower limit of 48 semi-structured interviews in four study sites: 12 per site (2 implementers, 2 from community organisations representing tenants, 3 PRS property managers/landlords, 5 tenants). If needed, to help ensure diversity in the sample, we have an upper limit of 78 semi-structured interviews (along with the two workshops): 18 per site (4 implementers, 2 from community organisations representing tenants, 4 PRS property managers/landlords, 8 tenants). We will also hold two workshops (n=10 participants each). The first workshop will include national and regional stakeholders. The second workshop will include local stakeholders including, but not limited to, stakeholders working in our four study sites.

13. Participant selection

For the qualitative analyses, we will recruit stakeholders (national organisations, local implementers, PRS property managers/landlords, community organisations representing tenants, tenants). We will use our existing network of contacts and recruit locally through snowballing and advertising as required. See section 18 for further details. We will use interpreters if required (see Section 28 for further details).
The impact evaluation (WP1,3) is based on secondary data analysis and does not involve recruitment of participants.

14. Variables and data sources

14a. Variables

Individual-Level Outcomes

We have chosen outcome measures based on previous research on housing interventions and policy aims. Poor quality homes and unsafe neighbourhoods present both mental and physical risks. Our primary outcome will be **high levels of anxiety self-reported in the Annual Population Survey (APS)**, measured as people reporting a score of more than 6 in response to the question "Overall, how anxious did you feel yesterday?", where 0 is `not at all anxious' and 10 is `completely anxious'. A threshold of more than 6 on the 11-point scale has been identified by the ONS as a measure of high anxiety levels.

Our secondary outcomes will be the **three other measures of subjective wellbeing (happiness, life satisfaction and feeling worthwhile)** included in the APS. We will also examine **the general self-reported health measure collected by the APS** as an indicator of health that includes both mental

and physical health. To investigate potential unintended consequences of SL, we will also examine the **APS respondent's number of years at the current address** as an indicator of residential stability.

Area-Level Outcomes

Our primary area-level outcome will be the **Small Area Mental Health Index (SAMHI)** and its individual domain scores. The index is available for LSOAs on an annual basis [37]. It combines the following measures of mental healthcare use into a single index: mental health-related hospital admissions, antidepressant treatment days per population, proportion of the population diagnosed with depression, proportion of population in receipt of mental health-related benefits.

We will complement the analysis with an exploration of physical health outcomes. Since the treated areas are relatively small, most physical health outcomes are not available at the spatial granularity needed for the analysis. However, we can use **1. All-cause emergency hospital admissions** as an indicator of the population's overall health. The choice of emergency admissions are in line with the literature on preventable hospitalisation [38,39]. Similar measures have been used to evaluate public health and social care interventions, including housing [16,40]. Hospital admissions data are available for LSOAs on an annual basis. This indicator is equivalent and a counterpart to the mental health-related hospital admissions element of the SAMHI and can be extracted from the Hospital Episode Statistics data (NHS Digital), which the University of Liverpool has access to. In addition, we will examine **2) Cardiovascular emergency admission in 65+yr, 3) Respiratory emergency admission in 65+yr, 4) Emergency admission injuries falls/burns in 65+yr (any place of occurrence), 5) Asthma emergency admission, a) All ages, b) 0-14yr, c) 65+yr, 6) All-cause A&E attendance, a) All ages, b) 65+yr**. There is evidence for these outcomes showing associations with the home environment [41–43]. Older people are particularly vulnerable to poor quality housing. By the same token, we will study emergency asthma admissions among 0-14-year-olds. Rodgers et al. 2018 studied emergency admission injuries falls/burns in 65+yr occurring in the home. This level of detail, i.e. place of occurrence, is not available in the data available to us and we will study this is as 'any place of occurrence'.

Incidence of police-recorded ASB: High levels of ASB is one of the most common reasons for local authorities to implement SL [9] . These data are available for LSOAs on a monthly basis [44].

Population turnover index: An increase in population turnover might indicate unintended consequences of SL. The population turnover index is based on a combination of electoral roll and consumer data [45].

Tenants' rent (£): We have gained access to Zoopla Property Data through the Urban Big Data Centre at the University of Glasgow [46]. Zoopla is one of the largest online property advertising companies. The Zoopla data affords a much higher level of granularity than government data on property rents, which are only available at regional level. The data are based on daily extractions, so they reflect day-to-day advertising rather than stock value at any given moment.

University of Glasgow (pers. comm., 17 Jun 2024), the owner of the Zoopla rent data, does not recommend combining data from before and after they changed the way they scrape the data from the Zoopla website in 2019. The first full year of data is 2012. Therefore, for this outcome measure we will study only 2012-2018 instead of 2011-2019.

Listings were selected that qualified on the following criteria (Figure S2): Generation 1 Zoopla data, rentals, residential 2-bedroom properties, non-missing last marketed data 2012-2018, England, first listing per property per year.

We will use the mean rent for a 2-bedroom home with the bottom and top centiles removed to address outlier issues. We will also study the same for 2-bedroom flats ('flat' or 'block of flats') as the most commonly occurring property type.

Matching variables

We have chosen matching variables measured before the interventions or as close as possible to this time point from Census 2011, Indices of Multiple Deprivation, and council tax data. From Census 2011 we use the proportion of the population that are <16 years, proportion of the population aged 16 to 59 years, proportion of the population who are non-white and proportion of households from private rented sector. From the English Indices of Deprivation 2015, we use the proportion of population experiencing deprivation related to income, proportion of social and private homes that fail to meet the Decent Homes standard, proportion of households classed as overcrowded and an indicator of inability to afford to enter owner-occupation in the private rental market. Finally, we create a built pre-1945 indicator. The data on dwelling construction era were only 96.9% complete and were hence imputed sequentially with non-missing values from nearest LSOA11 neighbours (geodetic distance) (Table S3). For each LSOA11, the most common construction era was selected. In cases with ties (2.95%), the earliest construction era was selected.

14b. Data sources

The APS data for the individual-level outcomes come from ONS and access to the data through the Secure Research Service (SRS) was approved on 2 Aug 2024 [47].The sources of the area-level outcome measures are the University of Liverpool Place-based Longitudinal Data Resource [37], NHS Digital [48], Police.uk [49], University of Glasgow Urban Big Data Centre [46], and ONS [47]. The sources of LSOA characteristics used for matching are the Department for Levelling Up, Housing and Communities [50], and ONS [51,52].

15. Data collection and management

Qualitative data (forms and transcripts) will be collected by the LSHTM researcher (Dr Seguin and qualitative research fellow) and stored on LSHTM secure password-protected servers. Dr Seguin will be the data custodian for the qualitative data. Transcription will be carried out by a trusted, third party, EQ Transcription Services Ltd., Kemp House, 152-160 City Road, London, EC1V 2NX, Tel: +44(0)2071124887 or an alternative transcription service recommended by LSHTM. The data will be anonymised and transferred using a secure file server. We will respect participants' right to withdraw from the study at any point. We will store data electronically, copying any paper-based data into an electronic format and destroying the paper originals securely. All data collected and produced by the project will be stored securely for 20 years.

Quantitative analyses will only involve secondary data and be carried out on password-protected university servers unless otherwise specified by agreements with data providers. Agreements with data providers will be adhered to – including use of secure data environments.

16. Blinding

Blinding is typically not feasible for natural experiments, e.g. if – as in this study - there are multiple control units per treated unit.

17. Potential bias

We will assess the robustness of our results in two ways: exposure falsification, i.e. assigning intervention status to a matched control area and outcome falsification, i.e. assessing an outcome

measure that is unlikely to be affected by SL. At area-level we will use annual precipitation as a placebo outcome. Each LSOA unit will be assigned the annual precipitation value (mm) of the nearest 12-km grid node. At individual-level we will explore the variables available in the APS for potential placebo outcomes.

18. Analysis plan

Work package 1: Impact evaluation

Objective

To assess area and individual level impacts of SL schemes on health and social outcomes. To assess impacts on equity.

Selection of treatment areas

We have identified all Lower layer Super Output Areas 2011 (LSOA11) with 5 to 100% coverage of Selective Licencing (SL) schemes initiated between 2007 and 2021. These data were obtained through FOI requests to local authorities who provided information of the geographical areas covered by SL schemes. These could be based on various geographies (e.g wards, LSOAs, streets or other bespoke geographies). We mapped these geographies to LSOAs to provide the % of area in each LSOAs covered by a SL scheme. This process inevitably resulted in some small slivers and to avoid analysing areas that were potentially unexposed, LSOA11 with <5% area coverage were ignored.

We distinguish between treated areas, matched control areas, other untreated areas, and exclusion areas. The exclusion areas are defined as street-based schemes, pre-treated areas (2007-11), and future treated areas (2020-21). In addition, we define exclusive spillover areas as an alternative treatment category (see below).

Street-based schemes were taken out of the treated group and put in a separate category as there is insufficient contextual information on streets for the analysis, e.g. from official data sources such as Census (Table 3). We encountered three local authorities with street-based schemes, two solely street-based schemes in London and a small street-based scheme in a local authority that otherwise predominantly operated area-based schemes, Sheffield. In the case of the former, we have chosen to classify the whole local authority as 'Street-based schemes'.

LSOA11 treated before 2012 were removed from the treatment category and put in a separate category due to lack of outcome data for the early years of SL. Similarly, LSOA that were newly treated after the end of the 2012-19 study period, i.e. 2020-21, were put in a category of 'Future treated 2020-21' (Figure 1, Table 2).

We track how small areas (LSOA) have been part of one or more SL schemes over time within a local authority. The SL intervention will be analysed by the first year each LSOA11 was treated and treatment allocation has been fixed for methodological reasons regardless of whether a scheme got renewed after the first five years or not. Where the proportion of the LSOA covered by an SL scheme varied over time, the highest area proportion an LSOA11 unit had been exposed over time is used.

In the feasibility study in Greater London, partially treated areas were ignored. In the national study, however, many schemes could not be mapped 1:1 with LSOA11 units. They were either too small and/or defined with incongruent area units. Table S1 (Appendix I) shows the distribution of treated units by scheme and area coverage categories. The fragmented areas are likely to be different from the areas with larger and intact schemes such as London and Liverpool. It could hence create a selection bias problem if these more fragmented areas were excluded. Including the fragmented

LSOA11 units in the analysis (N=279), on the other hand, creates a measurement error problem (Figure S1). The main analytical approach will therefore be analysis of treated areas with 100% coverage accompanied by sensitivity analyses that gradually adds the more thinly covered areas until all areas with at least 5% coverage are included.

A total population of 2,807,326 (Census 2011) resided in the standardised LSOA11 areas across 64 SL schemes in 41 different local authorities (Table 2, Table S1). Within these schemes, 777,688 persons were living in private rental accommodation (Census 2011).

Table 2 Population estimates (Census 2011) and number of 2011 Lower Layer Super Output Area (LSOA11) units of Selective Licencing (SL) schemes in England 2012-19 by SL area coverage categories. The main analysis will be of the 5%-100% category as if fully treated. Sensitivity analyses will gradually deselect the more thinly covered areas until only fully treated areas are left, i.e. the '100% only' category.

Coverage	LSOA11 units	Population	Private rental tenants
5%-100%	1,635	2,807,326	777,688
50%-100%	1,506	2,586,069	712,661
100% only	1,356	2,329,792	637,541

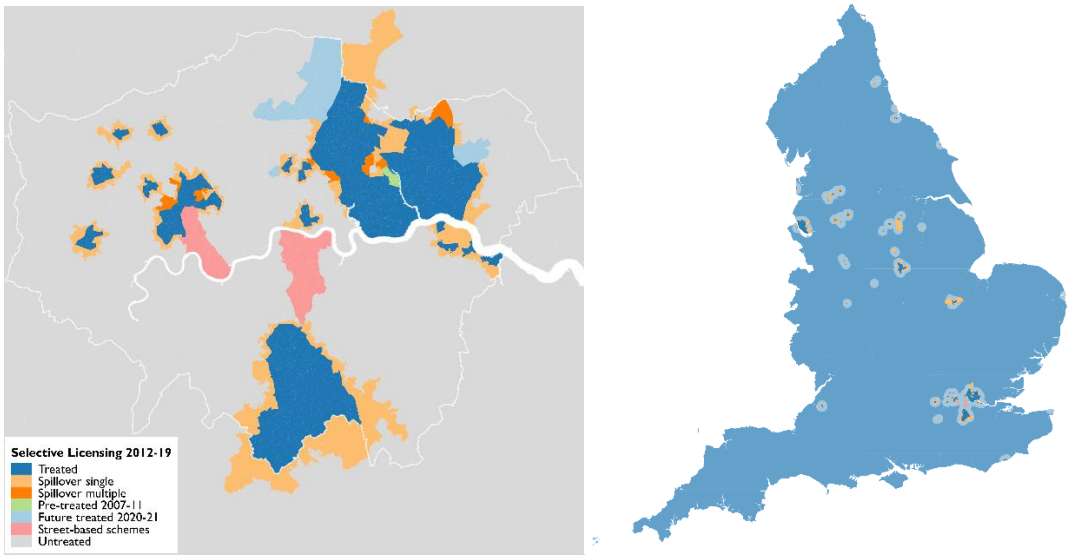

Figure 1 Selective Licencing treatment, spillovers, and exclusion areas (2012-19) for London (left panel) and England (right panel with 5km buffer to highlight smaller schemes).

Table 3 Selective Licencing schemes in England 2012-19. Number of standardised 2011 Lower Layer Super Output Area (LSOA11) by region. Regions were defined as 1) The North (North East, North West, Yorkshire and The Humber), 2) The South (East Midlands, East of England, South East, South West, West Midlands), and 3) Greater London.

Category	The North	The South	London	Total
Untreated	7,561	17,465	1,916	26,926
Treated	470	235	930	1,635
Matched control	967	581	1,271	2,819
Spillover single	293	233	271	797
Spillover multiple	28	3	15	46
Street-based schemes	2	-	279	281
Pre-treated 2007-11	94	7	9	110
Future treated 2020-21	56	14	144	214

Total	9,471	18,538	4,835	32,844

Definition of spillover areas

An area-based policy could have spillover effects, e.g. if tenants get forced out by increasing rents or a more ardent use of antisocial behaviour clauses. At the same time, landlords and letting agencies could potentially move their businesses away from SL areas to avoid regulation. To study such spillover effects, we have selected areas adjacent to treatment areas. We are acknowledge there are limitations with this definition of spillover – given that displacement of tenants (or landlord properties) may not necessarily be to those adjacent areas. However we have no means of tracking individual displacement events, so our use of adjacent areas represents what we believe to be the best way of assessing this issue that our data will allow. Nonetheless, we will make clear the limitations and clearly designate this part of our analysis as 'secondary.' For simplicity, spillover, and control areas have been defined as mutually exclusive.

Specifically, spillover areas were selected as LSOAs adjacent to treated LSOAs by the year they first gained spillover status. In the selection, treatment status would 'overrule' spillover status. This is particularly evident in London where schemes in some cases are adjacent to other schemes. The exclusion areas, i.e. street-based, 'pre-treated 2007-11', and 'future treated 2020-21' schemes, also 'overruled' potential spillover status. A small proportion of spillover areas gained that status more than once (N=46, Table 3). This is noted as a limitation but the multiple spillovers will pragmatically be included in the analysis of any spillover effects overall.

A set of spillover control areas will be selected following the same methodology as for the treatment control areas (see next section). All treated units were urban areas and only urban areas were included in the pool of control candidates for treated areas. Since some spillover areas were in fact rural, all areas were included in the pool of candidates for the spillover controls regardless of urbanity.

Selection of control areas

Only areas that were untreated and did not qualify for any of the exclusion criteria were entered into the pool of control candidates (Table 2). SL schemes were only introduced in urban areas and rural LSOA11 were accordingly excluded from the matching pool.

Variables (LSOA11-level) for matching were proportions of the population in receipt of income benefits, self-reported non-white ethnicity, and proportions of households from the private rental sector, living in housing in poor condition, overcrowded, or unaffordable, whether buildings were mainly built before 1945 (Table 4). Skewed variables were logarithmically transformed (natural logarithm) prior to matching.

Propensity score matching (PSM) with 1:3 controls and replacement within each super region was used for the treatment (Table 4, Table S4) and spillover units (Table S5-S6) [53].

Table 4 Baseline characteristics for Treated, Never-treated, and propensity score matched control areas (1 treated:3 controls) with replacement. Number of standardised 2011 Lower Layer Super Output Area (LSOA11).

A **Matching variables**	**B** **Treated**	**C** **Never-Treated**	**D** **Matched Controls**	**E** **Std. dif. (B-D)**
THE NORTH	N=470	N=7,255	N=1,410 (967 unique)	
Age 0-15 years	.18	.19	.18	.06

Age 16-59 years	.63	.58	.64	-.07
Ln(Income deprivation)	-1.42	-2.04	-1.47	.06
Ln(Private rental)	-1.58	-2.19	-1.57	-.02
Unaffordability	.93	-.53	.82	.06
Ln(Poor housing cond.)	-1.34	-1.62	-1.34	<-.01
Ln(Overcrowding)	-2.56	-3.09	-2.59	.05
Ln(Non-White)	-2.52	-3.18	-2.56	.04
Pre-1945 construction	.76	.45	.76	<.01
THE SOUTH	N=235	N=13,746	N=705 (581 unique)	
Age 0-15 years	.19	.19	.19	-.11
Age 16-59 years	.66	.58	.65	.10
Ln(Income deprivation)	-1.61	-2.24	-1.57	-.06
Ln(Private rental)	-1.37	-2.08	-1.42	.08
Unaffordability	1.30	-.11	1.21	.05
Ln(Poor housing cond.)	-1.26	-1.64	-1.28	.07
Ln(Overcrowding)	-2.10	-2.90	-2.15	.06
Ln(Non-White)	-1.48	-2.73	-1.47	-.01
Pre-1945 construction	.65	.35	.65	.01
LONDON	N=930	N=3,179	N=2,790 (1,271 unique)	
Age 0-15 years	.22	.19	.22	-.06
Age 16-59 years	.64	.65	.64	.07
Ln(Income deprivation)	-1.75	-2.12	-1.75	.01
Ln(Private rental)	-1.51	-1.63	-1.58	.11
Unaffordability	2.43	1.55	2.32	.08
Ln(Poor housing cond.)	-1.52	-1.53	-1.53	.03
Ln(Overcrowding)	-1.59	-1.87	-1.65	.08
Ln(Non-White)	-.72	-1.24	-.76	.06
Pre-1945 construction	.76	.70	.76	.01

Data sources: Indices of Multiple Deprivation 2015 [54]; Census 2011 [51]. Abbreviation: Households (hh), Standardised distance (Std. dif.). Regions were defined as The North, The South, and London.

Variable transformations

We will apply non-linear DID models [55] such as Poisson models for counts or, alternatively, using logit models and dichotomising the specific outcome variables. This way we can avoid the usual approach of log transforming outcome variables, which has implications for the parallel trend assumption [56]. Log transformation would require as-random treatment allocation (not our case) or checking that the outcome distribution is not affected by the intervention itself. Log transformation also affects the interpretation depending on the model, e.g. from measuring additive to multiplicative effects [57].

Sub-Group Analysis

We will repeat our analyses of individual- and area-level outcomes for the following subgroups:

- **Small versus larger SL schemes**. We propose this partly because the larger schemes have been politically contentious (following the change of government in 2024, changes were announced to make it easier for LAs to set up large schemes without needing national government permission), and partly because we hypothesise that resident displacement occurs less in larger schemes – particularly where the schemes extend across the whole local authority area. For this purpose, we will define larger schemes as those covering 90%+ of the Local Authority population (Census 2011): 2012_Newham, 2014_BarkingandDagenham,

2015_Croydon, 2015_Liverpool, 2015_WalthamForest. Small schemes will in this analysis be defined as those covering up to 20% of the population. Schemes of intermediate sizes will be ignored in this analysis.

- **London versus outside London.** Comparisons with London are useful because it has a unique housing market and some of its areas were settings for the Olympic Games (a potential confounder).

To examine impacts on equity, we will run the following area-level subgroup analyses by ranking local authorities:

- **Level of deprivation**: lower half (least deprived), upper half (most deprived)
- **Proportion of population from a Non-White ethnic background**: lower half (low proportion), upper half (high proportion)
- **Proportion of population under 16**: lower half (low proportion), upper half (high proportion)
- **Proportion of population over 75**: lower half (low proportion), upper half (high proportion)

APS includes items that are relevant to the following equity dimensions covered in the PROGRESS+ framework: Place of residence (which we operationalise as region); Ethnicity, Occupation, Gender, Religion, Education as well as participants who live on their own and participants with child dependents. Occupational status and education can be considered proxies for socio-economic status. Furthermore, the survey asks about long term and limiting health conditions, allowing us to consider these dimensions of disability. It also asks about cohabiting same sex partners. We will incorporate these dimensions into the equity analysis where sample sizes allow us to do so.

To address potential multiple testing issues with the secondary analyses, will adjust the significance tests according to a Benjamini–Hochberg False Discovery Rate of 5% [58].

Software

The analyses will be carried out in Stata (version 18 or later)[59] or R.

Work package 2: Process Evaluation

Objective

To assess SL in terms of the following (i) stakeholder acceptability (ii) pathways to impact, (iii) unintended and systemic consequences; (iv) barriers/facilitators; (v) equity assessment.

Overall approach

The process evaluation will be primarily qualitative: n= 72 qualitative semi-structured interviews with stakeholders (tenants, landlords, implementers and representatives of stakeholder organisations); a national and a local workshop (n=10 for each); document analysis. Data collection will mostly focus on 4 ‘case’ SL sites.

National stakeholder workshop

Early in WP2, we will hold an online workshop with national stakeholders (n=10) to assess views on how SL fits with national policy on housing and health. Through the workshop, we will develop our initial logic model (Appendix) into a more detailed map that provides a further breakdown of the intervention’s core stages on the pathway to different impacts, situated in a wider system. To assist us, we will draw on strong structuration theory’s framework, consisting of 4 elements: external

structures, internal structures, action/active agency and outcomes [60]. We will draw on this framework because it is designed to help users consider both agency and underlying (internal and external) structures; and because it can be used to consider multi-stage pathways to impact. We will focus particularly on equity impacts. The revised map will inform the rest of the work package, adapting an approach described in McGill et al, 2020 [61].

The national workshop will be asked to consider potential beneficial impacts, barriers and unintended consequences (including our own hypotheses on these: see above and also see logic model). As part of the exercise they will also be asked to think of systemic pathways to impacts not covered by our hypotheses. We ask specifically about equity impacts and about policy priorities and how they might be influenced by SL.

Local stakeholder interviews, document analysis and workshop

We will then sample local stakeholders who can talk to us about how/if change in their area occurs in ways suggested by the National Workshop's systems map and hypothesised pathways. We will sample 4 SL schemes for qualitative fieldwork. The law distinguishes between smaller (up to 20% of homes) and larger schemes, so we will sample a smaller and larger scheme in both the North and South of England. Hackney, Newham, Gateshead and Liverpool meet this sampling criteria and have expressed interest. Data collection proposed for those case studies will be an upper limit of 72 semi-structured interviews: 18 per site (4 implementers, 2 from community organisations representing tenants, 4 PRS property managers/landlords, 8 tenants). Interviews approx. 1 hour; remote or F2F depending on interviewee preference. Tenants compensated for time with £20 shopping voucher + travel expenses fowor F2F.

We have also introduced a lower limit of 48 semi-structured interviews: 12 per site (2 implementers, 2 from community organisations representing tenants, 3 PRS property managers/landlords, 5 tenants). Criteria for lower limit will be (i) saturation; or (ii) sample frame being met. Sample frame (per site) = 1 senior and 1 front line implementer; 2 representatives from community organisations for tenants; 1 small, 1 medium and 1 large landlord; tenants must include men and women, people with and without child dependents, white and BAME ethnicity. The majority of tenants must have a smaller than average household income for their area. Contact questions during recruitment stage will establish these criteria.

Interviews approx. 1 hour; remote or F2F depending on interviewee preference. Tenants compensated for time with £20 shopping voucher + travel expenses for F2F.

Document analysis: includes reports, compliance and enforcement data, consultation documents, budgets for each site, landlord and tenant forums. Document analysis: includes reports, compliance and enforcement data, consultation documents, budgets for each site, landlord and tenant forums.

Online workshop with local stakeholders (n=10) to interpret early findings.

The interviews for the 4 case studies will provide local perspectives on SL from tenants, landlords, implementers and other stakeholders. Topic guides will vary by stakeholder group, focusing particularly on issues, experiences, hypotheses and impact pathways relevant to each type of stakeholder. However, they will each consider the following core themes: (i) stakeholder acceptability (ii) pathways to impact, (iii) unintended and systemic consequences; (iv) barriers/facilitators; (v) equity. We will ask stakeholders to talk about their own experiences and provide opportunities for them to give their views about the PRS, SL and its (equity) impacts.

Recruitment and sampling.

We will recruit people from the following groups: national stakeholders, local implementers, PRS property managers/landlords, community organisations representing tenants, tenants.

- Our national workshop will include stakeholders identified using our current contacts and networks – with snowballing as required. National government includes Department for Levelling Up, Housing and Communities; Department of Health and Social Care; Office for Health Improvement and Disparities; Local Government Association. We may also include a minority of stakeholders responsible for larger regions: e.g. devolved regional authorities such as Greater London Authority. We also have contacts with national housing charities for a non-governmental perspective: e.g. Shelter and Crisis. We would expect a range of policy perspectives across this group.
- Interviews with local implementers will focus on the four case study sites. Job roles and management structures for each site will vary but in each we would recruit the SL lead, a frontline PRS regulator/inspector, an implementer overseeing finances, a public health representative. We would contact and invite interviewees through established contacts at each local authority.
- Interviews with representatives from landlords (small and large businesses), property managers and community organisations. We will have a dual approach. Firstly, we will ask the local authority leads to identify relevant stakeholders from these groups. Secondly, we will conduct our own bespoke search for relevant local stakeholders through google and social media forums (e.g. Facebook and Twitter), snowballing if necessary. We had previously assumed that local authority recommendations might lead us to stakeholders who are more supportive of SL, while our own search could identify stakeholders with a more critical stance. In practice, we found critical and supportive viewpoints from stakeholders identified through both these approaches.
- Interviews with tenants. In our experience this is the most difficult group to recruit from. We plan to begin by involving a community representative from each site to assist with our local recruitment strategy. We would recruit via local authority, community groups (online and physical), and advertising via face book and local newspapers. In each site we would ask for expressions of interest, and then make a follow-up contact (by phone, email, zoom – depending on person's preference) to ask for some initial details. This is to help us ensure the following characteristics are varied in each site: age (retired vs working age); gender; disability and ethnicity. We will then select interviewees and begin a process of informed consent.
- Omissions. We think it likely that the worst offending (e.g. 'rogue/criminal') landlords will be unwilling to participate. We will prioritise recruitment of tenants experiencing some form of disadvantage: during our tenant recruitment process we will ask about their rent, property and household employment situation to identify tenants with low SES. This means we will hear less from affluent tenants. We also think it realistic to assume that some tenants, including some disadvantaged tenants, will be unaware or unwilling to participate in the study despite our best efforts.

Duty of care

While our questions are not intended to be highly sensitive, we recognise that some participants may choose to describe experiences they find upsetting. Some – notably tenant participants – may ask researchers to help them with housing problems or other difficulties. We must recognise that the researchers are not experts in housing rights, nor are they qualified to give health related advice. We have prepared a short list of services and resources (see Appendix II) for researchers to offer to participants if required.

In terms of researcher safety, we intend to do most data collection remotely (e.g. phone or online) or in public settings. However, we will give weight to participant preferences, meaning that it is possible some interviews may occur in a participant's home. We have a protocol for fieldwork in

participant's' homes to ensure staff whereabouts are known and a response process is in place (see Appendix III).

Data collection

As stated above, the study involves a mixture of group workshops and individual semi-structured interviews. In the appendix we provide topic guides for (i) national workshop, (ii) local interpretive workshop, (iii) tenant interviews, (iv) landlord interviews, and (v) stakeholder interviews.

Analysis and outputs

Analysis of qualitative data will include the following approaches. We will use the first workshop to help us (i) transform our initial logic model into a conceptual map of the wider system within which SL occurs; and (ii) finalise a list of hypothesised impact pathways (both beneficial and detrimental impacts). This will inform our topic guide development for the case studies [61]. During our analysis stage we will hold our second stakeholder workshop to present some early findings and ideas and learn from stakeholders responses to these.

Analysis of case study data will include different approaches leading to at least three peer review articles.

Article 1: To assess pathways to impact and their barriers and facilitators, we will draw on strong structuration theory's framework, consisting of 4 elements: external structures, internal structures, action/active agency and outcomes [60]. We have used it previously in an approach that combines document analysis with interview data – we will further develop this approach.

Article 2: Equity assessment. While article 1 will focus on the main pathways to impact, the second article will focus specifically on how and why differential impacts occur. Our plan is to again use the strong structuration approach to (i) identify and unpick a wide range of hypotheses (building on those we have already considered) to explain differential effects, and identify the social groups affected, intersections that may occur, and the agentic and structural factors underpinning the (re-)production of privilege and discrimination within the 'PRS system.'

Article 3: Equity – emergent theme(s). This article will be a more traditional thematic analysis of emergent themes. We are deliberately leaving this paper open, as we think a key benefit of qualitative research is that it helps researchers identify issues that were not necessarily prominent in our thinking at research planning stage. As we progress through our analysis for article 1 and 2, we will agree on a critical issue affecting health equity and focus on that issue in more detail for article 3. Ideally, we would like this to exemplify something we regard as crucial to the wider understanding of 'upstream interventions.' We are interested in exploring how system adaptation to housing and place interventions leads to unintended consequences. Providing we have capacity and resource, we may conduct a small number of additional or follow-up interviews to provide further data on the issue(s) we focus on (max. 10 extra participants).

Work package 3: Economic evaluation

Objective

To assess whether SL schemes are value for money.

Approach

The economic evaluation will produce a cost-benefit analysis that uses the subjective wellbeing approach to monetise the benefits of SL. A cost-benefit analysis is better suited to assessing the

value of SL than a cost-effectiveness analysis. A cost-effectiveness analysis requires a comparison between alternatives, such as providing patients with a certain disease with usual treatment versus a new treatment. SL has no obvious alternative. Rather than informing policy makers about which of two options to choose to achieve an outcome that has already been agreed is worth achieving, the purpose of this economic evaluation is to inform policy makers whether this type of intervention is worth doing or if local governments' resources might be better spent on different programmes.

Using the subjective wellbeing approach to determine the monetary value of the benefits of SL avoids the problems of traditional preference-based methods of valuing non-market goods. The subjective wellbeing approach measures people's experiences instead of their preferences. It assesses the impact of non-market goods, policies, or events on how people think and feel about their lives as a whole. This impact is then converted into a monetary figure by comparing it to the effect of income on subjective wellbeing [62]. For example, if a policy increases subjective wellbeing by 0.5 on the 0 to 10 scale and similarly a £5,000 increase in income results in a 0.5 increase in subjective wellbeing, the value of the policy to the individual is assumed to be £5,000. The data on subjective wellbeing is being collected without any reference to the policy under consideration. Thus, the subjective wellbeing approach avoids the two main problems of stated preference methods which attempt to elicit individuals' "willingness to pay" for a particular outcome: When asking people how much they would be hypothetically willing to pay for a certain outcome, they tend to overstate their valuation of a good or they strategically misrepresent their true preferences [62]. The subjective wellbeing approach also avoids the problems of revealed-preference methods, which infer the implicit price of, for example, an environmental amenity by comparing the prices of houses that have similar characteristics except for the level of the environmental amenity. This method requires assuming that housing markets are in equilibrium, that individuals have full information on all house prices and characteristics and that there are zero transaction and moving costs. These assumptions are unlikely to be met [62].

If we measured the benefits of SL only in terms of QALYs or increases in employment rates or reductions in antidepressant prescribing costs to the NHS, we would miss the value of impacts that are difficult to measure but are potentially more important to people. Focusing on outcomes such as QALYs or employment captures the instrumental value but ignores the intrinsic value of improvements in housing quality.

The starting point for the calculation of the benefits of SL will be the estimate of the impact of SL on the life satisfaction variable from the APS, one of our secondary outcomes. We will then follow the procedure described in Dolan et al. (2019) [35]. Essentially, we will use an estimate of the impact of income on life satisfaction from previous research to determine the income change that would be required to achieve the same change in life satisfaction as achieved by SL. Multiplying this income change amount by the number of individuals affected by SL will provide the total benefit of SL. All our calculations will be retrospective and estimate the benefits of SL over our 2012 to 2019 sample period.

We will calculate the costs of SL from a public sector perspective. To determine the total cost of SL over the 2012 to 2019 sample period, we will measure the direct and indirect cost of SL in four case study sites. Accounting data provided by the case study sites will be the starting point for the cost calculation. However, the economic concept of opportunity cost goes beyond accounting cost. For example, local authorities might employ staff specifically for the administration of the SL schemes in their area, so these costs would be included in the accounting data as staff salaries and on-costs. However, staff not specifically employed for SL purposes might also be involved in administering local schemes. Any staff involved in SL will require office space and might need to be trained and supervised. Local authorities need to disseminate information about their SL schemes using their website or other means and maintain the online application system. All these activities incur costs, either directly in the

form of money being handed over in payment or indirectly in the form of resources such as staff time or office space not being available for alternative uses.

The four case study sites have been selected to represent different types of SL (smaller and larger) in different regional contexts (north and south). We will use extrapolation methods that use these two broad characteristics as well as cost information obtained through FOI requests to assign costs to the other local authorities that have implemented SL. We will subtract income from license fees to obtain net costs.

In addition, we will estimate the potential costs saved by the NHS through SL's impact on antidepressant prescribing, mental-health related hospital admissions and all-cause hospital admissions over our sample period. If possible, we will also estimate potential cost savings through impacts on mental health-related benefits. If we find substantial cost savings, we will subtract these from the cost of SL to local authorities to obtain net costs from a public sector perspective.

Work package 4: Knowledge exchange, dissemination, impact

Objective

To share and interpret findings with stakeholders.

Approach

Knowledge Exchange will involve an interpretive workshop (see WP2), and an online engagement event for a larger audience. Our policy and practice links include charities (Shelter, Crisis, Safer Renting), national government, local government, the London Public Health and Housing Network, Equal England and NIHR ARCs. The research team have an excellent track record in producing material for non-academic audiences as part of an impact pathway and we will consult with practice and public partners on how best to disseminate findings to target audience. We include some relevant letters of support. We have costed for four open access academic publications (noting that not all publications involve project-level fees) and UK conference presentations. For the study to have impact it should inform future decisions to implement SL schemes and influencing national policy on licensing.

19. Handling of missing data

Missing data does not constitute a significant issue with the listed data sources and the analyses will be conducted as complete case only.

20. Handling of withdrawals and replacements

Not applicable.

21. Outcome

Primary and secondary outcomes are described in detail in Section 18 as part of the detailed analysis plan. They are summarised here.

Work package 1.

Area level:

Primary outcome: Mental health and wellbeing (SAMHI)

Secondary outcomes: Emergency hospital admissions: all cause; cardiovascular; respiratory; injuries due to falls or burns; asthma. Reported anti-social behaviour. Population turnover. Average cost of rent.

Individual level:

Primary outcome: Self-reported anxiety (ONS APS).

Secondary outcomes: General self-reported health, residential stability (ONS APS).

Work package 2.

Qualitative 'outcomes': stakeholder acceptability; pathways to impact; unintended and systemic consequences; barriers/facilitators; equity assessment.

Work package 3.

Outcome: Benefit-cost ratio for SL - to monetise the benefits of SL, we will apply the subjective wellbeing approach described in section 18 to the ONS APS outcome: self-reported life satisfaction.

22. Data confidentiality statement

Quantitative analyses will only involve de-identified secondary data and be carried out on password-protected university servers unless otherwise specified by agreements with data providers. Agreements with data providers will be adhered to – including use of secure data environments. The qualitative component of the study will only collect data from consented participants. The data will be anonymised and stored on secure file servers. We will also respect participants' right to withdraw from the study at any point.

23. Follow-up

The quantitative part of the study will only involve deidentified data where follow-up is not possible.

The qualitative part of the study mostly consists of single participation points (i.e. a single interview or workshop attendance) for stakeholders who participate. However, we have allowed ourselves some flexibility to re-interview a small number of participants. We have done this so that we can ask for further details if we think it helpful or ask about an emerging issue. Our section above on work package 2 includes the statement: "Providing we have capacity and resource, we may conduct a small number of additional or follow-up interviews to provide further data on the issue(s) we focus on (max. 10 extra participants)." We may also invite some interview participants to one of our workshops or ask a workshop participant if they are willing to be interviewed. The information and consent process will make clear that this possibility of follow-up exists and is something that participants are free to accept or decline. Transcripts for follow-up participants will be treated similarly to other transcripts: they will be anonymised and stored securely.

24. Plan of study monitoring

Role of study sponsor and funder

The sponsor is the organisation assuming overall responsibility for the initiation and management of the study. The funder is funding the study following an application process involving internal and external peer review and revision.

The research team are responsible for the study design, conduct, data analysis and interpretation, manuscript writing, and dissemination of results. The research team report to the funder, including reporting of the protocol and outputs. The views expressed are those of the authors and not necessarily those of the NIHR or the Department of Health and Social Care.

Roles and responsibilities of study management committees/groups & individuals

Data Monitoring and Ethics Committee (DMEC)

The DMEC will meet once a year: extra meetings can be called if there is a need. It consists of three independent experts with expertise in the subject area and in qualitative and quantitative data. The researchers will report to the committee on what we have done to ensure our data collection, storage and use is compliant with good practice, and whether or not the primary research is generating any harms or ethical issues. We are using 'routine' secondary data for our impact and economic evaluations: hence we will provide information to the DMEC to show we are meeting our ethics requirements and data agreements relating to the use of those data. Our only primary data collection is qualitative (the WP2 process evaluation). We will share details of our recruitment and consent process, and data privacy and security, and update on any emergent issues during the study. In a worst case scenario, we would call the DMEC to consider how to respond in the event an emergent problem serious enough to require a decision about continuing the study. We cannot predict all potential circumstances that would lead to such a scenario, but we assume it would be something important enough to challenge our view that the study carries no serious risk of harm.

Independent Steering Committee

The role of the Committee is set out here and repeated below.

The role of the Steering Committee is to provide overall supervision for a project on behalf of the study's Sponsor and Funder and to ensure that it is conducted to the rigorous standards set out in the UK Policy Framework for Health and Social Care and the Guidelines for Good Clinical Practice.

The day-to-day management of the study is the responsibility of the Chief Investigator, and as such the Chief Investigator may wish to set up a separate Study Management Group to assist with this function.

The main features of the Steering Committee are as follows:

- To provide advice, through its Chair, to the study's funder, sponsor, Chief Investigator, host institution, and contractor
- To concentrate on the study's progress, adherence to the protocol, and patient safety (where appropriate), and to consider new information of relevance to the research question
- To uphold the rights, safety and well-being of the participants: these are the most important considerations and should prevail over the interests of the research
- To ensure appropriate ethical and other approvals are obtained in line with the project plan
- To agree proposals for substantial protocol amendments and provide advice to the sponsor and funder regarding approvals of such amendments
- To provide advice to the investigators on all aspects of the study

Constitution of a Steering Committee

The relevant NIHR Programme Director will review the nominees and appoint the Chair and members. Independent members must make up a minimum of 75% of the Committee membership. The minimum quoracy for any Steering Committee meeting to conduct business is 67% (two thirds) of the appointed membership. Only appointed members will be entitled to vote (irrespective of their level of independence) and the Chair will have a casting vote. The Chair and members must sign and maintain a log of potential conflicts and/or interests. Attendance at Steering Committee meetings by non-members is at the discretion of the Chair. The primary Steering Committee reporting line is via the Chair to the relevant NIHR Programme Director; however, communication is likely to be between the Chair and the NIHR Research Manager who has day to day responsibility for the study.

The Committee will include representatives with the following expertise: NIHR PHR project management, qualitative research methods, statistics, economics, public involvement.

The Steering Committee will meet at least once a year and at least three times over the study periodS. Meetings may be online or face to face.

Study leads
The Chief Investigators will meet weekly (except for times when either is away from work). They may choose to invite others to meetings. The may discuss any aspect of project management during the meetings.

Study team
The study team is composed of the Chief Investigators, Co-Applicants and the two Research Fellows we will recruit. We will hold monthly meetings. These meetings may divide between those working on the quantitative work packages (WP1 and WP2) and those working on the qualitative and knowledge exchange work packages (WP2 and WP4). However, full team meetings covering all work packages will be held at least once every three months. Public representative co-applicants can attend any meeting, but we will specifically request that they attend full team meetings (financial compensation for their time at standard NIHR rates will be offered).

The Study Team's roles are as follows:
<u>Quants group</u>
Petersen: Oversight over whole project and WP1 lead.
Egan: Oversight over whole project.
Alexiou: WP1.
Fahy and Rose (joint RF post): WP1.
Janke: WP3 lead.
Barr: Expertise in quantitative routine data analysis.
De Vocht: Expertise in quantitative natural experiment evaluation.

<u>Qual group</u>
Egan: Oversight over whole project.
Seguin: WP2 lead.
Humphry: WP2 and WP4.
Marks: WP4 lead.
Stewart: Subject expertise (private rented sector).

<u>Public involvement co-applicants*</u>
Spencer: Private rented sector – third sector advice and support.
McDonald: lived experience.

*Note: a further public involvement group will be established involving a tenant from each of our four study sites. This will be referred to as the Public Involvement Group (PI Group). The PI Group will meet biannually and advise on all aspects of the study. We will particularly seek advice on study recruitment and knowledge of the study sites from the tenant perspective. McDonald and Marks will jointly convene these meetings. Other team members may attend as appropriate (to be determined by McDonald, Marks and PI Group members).

25. Training of surveyors/data collectors

Primary data will only be collected by the core research team (Seguin and qualitative research fellow).

26. Quality assurance

The quantitative data have been through quality assurance at the source. We will still carry out checks of data completeness, consistency, and outliers. Any changes will be justified and documented in syntax files.

Part D: ETHICAL CONSIDERATION

27. Ethical approval

The project will initially go through the ethical approval process at London School of Hygiene & Tropical Medicine (LSHTM submission number: 29809). On obtaining approval from LSHTM, we will then follow ethics requirements for each of the other collaborating universities (Liverpool, Lancaster, Greenwich, Bristol).

Quantitative component

The quantitative components of this study are based on routine data analysis so for this part there is no primary data collection. Ethical issues related to this part of the study focus on data privacy and security. We have access agreements with the following data providers: UK Data Service Secure Lab (Annual Population Survey - APS); NHS England / NHS Digital (Hospital Episode Statistics - HES); and Urban Big Data Centre, University of Glasgow (Zoopla data). These will be updated if necessary and adhered to.

The qualitative component of this study does involve primary data collection. Ethics issues include informed consent, privacy, data security and safeguarding participants.

We will conduct the quantitative analysis of Annual Population Survey data in ONS's Trusted Research Environment and only be able export results such as regression tables and graphs once these have been subjected to statistical disclosure control checks and cleared for release.

University of Liverpool's HES data sharing agreement (University of Liverpool - data sharing agreement DARS-NIC-16656-D9B5T-v6.1) allows members of the team based at Liverpool access to de-identified and aggregated HES data after a risk assessment within a trusted research environment. The Liverpool team will furthermore ensure that no patient will be indirectly identifiable in the outputs they produce (by e.g., suppressing small numbers or increasing the aggregation level).

Non-personal data from University of Glasgow Urban Big Data Centre (Zoopla property rental price data) will only be stored and handled on collaborating universities' secure servers. The analytical team will ensure that no individual address will be identifiable in the outputs they produce.

The other data we intend to use is publicly available, anonymous and does not pose a risk to individual confidentiality.

28. Consent and assent

Qualitative fieldwork is led by Dr Maureen Seguin along with a Qualitative Research Fellow (RF - to be appointed). Either Dr Seguin or the RF will take consent.

Dr Seguin completed LSHTM Research Ethics Training in October 2021. She has been taking informed consent for research projects with vulnerable groups since 2011. The Research Fellow will on appointment complete LSHTM Research Ethics Training, if they have not already received it in the last 3 years

Written consent will be required for all participants (implementers, other stakeholders, landlords and tenants). This will be done through signed informed consent forms that will be provided to the participants in advance. The forms include information on: the aims of the study, the voluntary nature of participation, their right/how to withdraw from the study, what participation to the study entails (including recording), the use and storage of data, and contact details of researchers. Copies of consent forms will be published on Open Science Framework (https://osf.io/pv57h/?view_only=a5a3ee644169483c8cec9cea63af2158; accessed 29 Oct 2023).

Our sampling frame is intended to cover a wide range of participants, so although it is possible that one or two participants may not speak English (or may struggle to speak it) we do not intend to recruit a large number of non-English speaking participants. Our advertising will be in English. However, we will seek out specific community groups in our 4 study sites, and these could include groups for migrant residents. If this is the case, we would discuss participation initially through an intermediary at the group. If the person expresses interest, we would have the material transcribed to the appropriate language. If the person still expresses interest, we would either (i) ask the person if they prefer to ask someone they know to help us with the translation process during consent and (if consent is given) data collection; or (ii) pay a translator. In our experience, the former is most likely - as participants like translation being handled by someone they know and trust - but we are equally prepared to hire someone if that is preferred.

Our recruitment process involves advertising through multiple methods. People will be invited to contact us to express interest and find out more. With all participants we will arrange a short call - usually by phone or online call. The purpose of this is to provide further information about the study to the person, answer any questions from the person, and establish whether the person is eligible for the study. By eligible we mean ask questions during this call to determine following:

1. Implementer – works for a local authority and is involved in the implementation of the licensing scheme (e.g. manages the scheme? works front line? Or has other role that links with the scheme? e.g. legal; finances; analytic; public health).
2. Third sector/community – works (paid or voluntary) for an organisation that is connected with private rented housing or with a community group that involves private rented tenants.
3. Landlords – rents property in a selective licensing area (a small-scale landlord with <5 properties or a medium/large scale property business?). Or provides a property management service for landlords operating in selective licensing areas.
4. Tenants – rents a home in a selective licensing area. To be eligible, the home cannot be a ‘House of Multiple Occupancy (HMO)’. Sampling frame includes men and women, people with and without child dependents, white and BAME ethnicity; people on an income lower

than the area average or living in disadvantaged area (we will find averages from the person's postcode).

If the person remains interested and is eligible, we will keep the information we have obtained from this conversation and move to the consent process. This begins with us sending the person the information sheet and consent form, going through them and then inviting the person to spend more time reading them.

There are a number of ways we can send this information - depending on the needs of the participant.

1. Email the documents.
2. Send the documents through a different electronic media.
3. Set up a web-based information sheet and consent form for the person to access and complete.
4. Post paper copies
5. Hand the documents over in person.

If data collection is remote (e.g. by telephone or digital platform) we will accept an informed consent process via email or via the posting of forms (participants will not have to pay for their own postage). Consent forms sent back to the researchers by participant's email can have an electronic or printed signature.

Informed consent forms will be sent to participants in advance. Participants may ask questions about the study prior to signing the consent form through email/telephone and before the start of the interview. The interviewer will introduce themselves, reiterate the information on the informed consent form and explain the interview procedure at the start of the interview. All participants will be reminded of their right to withdraw from the study prior to the interview.

£20 shopping voucher to tenants to compensate them for their time. We default to 'love2shop' vouchers but we will ask participants if they prefer a different voucher. We will try to accommodate participant preferences. If anyone has to pay for travel / subsistence or other reasonable expenses, we will compensate them for this (noting that most data collection will be remote).

We will ensure anonymity and privacy protection for all qualitative participants. No participants names will appear in any outputs. Any translators involved in the study will sign a confidentiality agreement (see attached document) prior to providing translation services. Signed consent forms will be stored electronically, and securely disposed of. All audio recordings will be deleted by the end of the study after transcripts have been verified.

The impact evaluation (WP1,3) is based on secondary data analysis with deidentified data and does thus not involve primary data collection.

29. Risk/harm to participants

While our questions are not intended to be highly sensitive, we recognise that some participants may choose to describe experiences they find upsetting. Some – notably tenant participants – may ask researchers to help them with housing problems or other difficulties. We must recognise that the researchers are not experts in housing rights, nor are they qualified to give health related advice. We have prepared a short list of services and resources (see Appendix) for researchers to offer to participants if required.

The impact evaluation (WP1,3) is based on secondary data analysis with deidentified data under secure settings according to data owners' conditions. Residual risks and harms are considered minimal.

30. Adverse and serious adverse event reporting

Not applicable.

31. Involvement of patient/participant representatives in study development

Our decision to focus on the private rented sector stems from public involvement work conducted as part of the NIHR School for Public Health Research. This involved consultative workshops with residents (n=10) who experienced different forms of housing disadvantage along with policy and practitioner workshops. From this, we learned that the private rented sector was a particular priority, with the physical quality homes, precariousness of tenure and inequalities all identified as major areas of concern for tenants. This led us to develop the London pilot study examining the impact of selective licensing schemes in London. The London study also included two public involvement representatives as well as a local authority practitioner with responsibility over private rented housing. Our current project also has two public representatives (RS and RM).

We have used our public and practice involvement to inform our research priorities, better understand the intervention from different perspectives, help develop our approach to research outcomes, qualitative sampling and recruitment, and knowledge exchange.

32. Supporting staff wellbeing.

The Data Monitoring and Ethics Committee advised us to consider staff wellbeing, as part of our ethics process, with particular emphasis on the wellbeing of the primary data collector (the person leading on conducting qualitative interviews).

As stated above, while our interview questions are not intended to be highly sensitive, we recognise that some participants may choose to describe upsetting experiences. We have already described our response with respect to the participant. Now we detail what is in place to support the data collector.

The qualitative data collector (Dr Debbie Humphry) is based at London School of Hygiene & Tropical Medicine. The following has been discussed and agreed with Humphry. LSHTM has the following support in place for staff.

LSHTM Support for Staff

- **Only Connect staff counselling service**. A trained counsellor can meet with you to discuss any issue and all issues will be treated confidentially.
- **Mental Health First Aiders.** An MHFA can provide immediate mental health support.
- **Employee Assistance Programme.** Available to all LSHTM staff regardless of role or location, LSHTM's EAP gives you access to independent and confidential support.
- **Human resources** also provide advice on where staff members may seek support.

Within this project team, two co-Is from LSHTM have completed training as Mental Health First Aiders: Seguin and Marks. Seguin line-manages the RF who leads on data collection (Humphry); while Marks is not in the RF's direct management chain. The data collector is encouraged to contact either or both MHFA if they wish to discuss issues that arise as part of their work in confidence. The data collector does not need to justify which MHFA they contact. Furthermore, Seguin and Humphry will be in regular contact (typically weekly) during periods of data collection to discuss the work, debrief and offer support if required.

MHFA are not trained mental health professionals but they are trained to actively listen, reassure, identify warning signs and help staff respond to a problem. They can also signpost staff to LSHTM's procedures, how to make a complaint and what support is available, in confidence.

While the DMEC has requested us to consider in particular the needs of staff conducting qualitative interviews, other members of the research team may also contact either of our MHFA co-Is in confidence.

Part E: REPORTING AND DISSEMINATION

32. Dissemination/publication plan

Dissemination will include: website blog and twitter posting from NIHR School of Public Health Research (SPHR); mail out and presentation to the London Public Health and Housing Network; emails to personal/professional contacts at a number of government, charitable organisations, think tanks and research organisations including: UK Collaborative Centre for Housing Evidence (CaCHE); Institute for Health Equity, Centre for Homelessness Impact, Greater London Authority, local authority contacts; Cambridge House; CRISIS; Shelter, MEDACT, Centre for London, Local Government Association; Equal North; relevant national government departments. In our submitted response to the peer reviewers, we added that dissemination plans will include the National Residential Landlords Association, Chartered Institute of Environmental Health and Chartered Institute of Housing. We will look for emergent opportunities such as government consultations. We will at minimum produce the following academic outputs: two articles for WP1 (individual and area level impacts), three for WP2 (see WP2 description above for details), one for WP3. We anticipate at least 4 conference presentations.

Part F: OTHERS

33. Whether Artificial Intelligence (AI) assisted technology was used in writing the protocol

AI was not used in writing the protocol.

34. AI statement

The authors did not use any form of AI in writing the protocol.

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36. Funding

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37. Open science

37a. Study registration

The study will be registered with Research Registry (https://www.researchregistry.com; accessed 29 Oct 2023).

37b. Data sharing

Protocols, consent forms, and peripherals will be published on Open Science Framework (https://osf.io/pv57h/?view_only=a5a3ee644169483c8cec9cea63af2158; accessed 29 Oct 2023). The quantitative data are available from the data owners subject to ethical and scientific approval.

APPENDICES

Appendix I – Figures

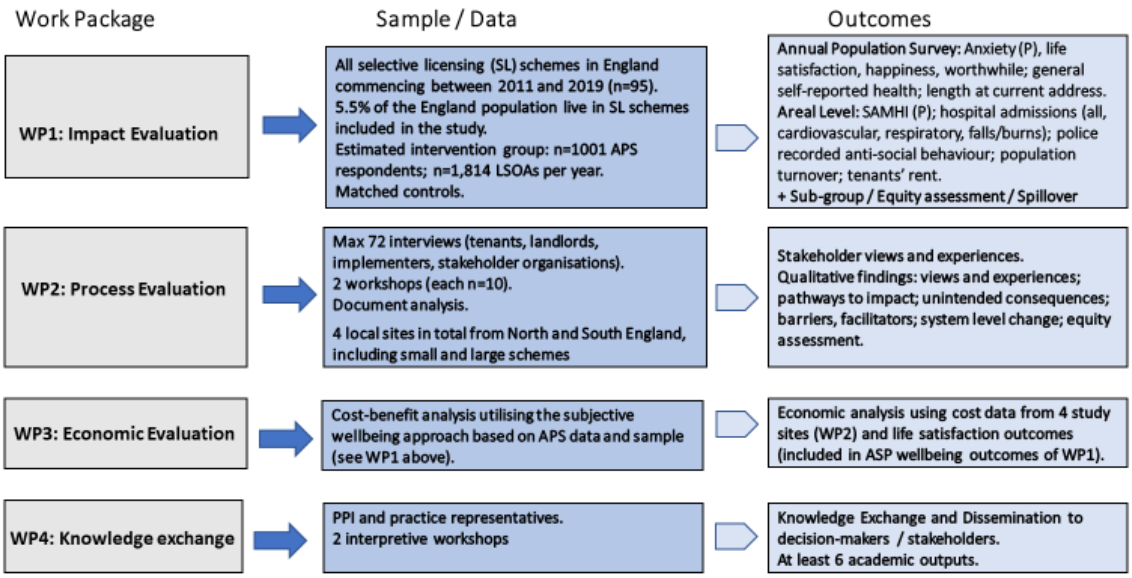

Figure 1 Work packages overview.

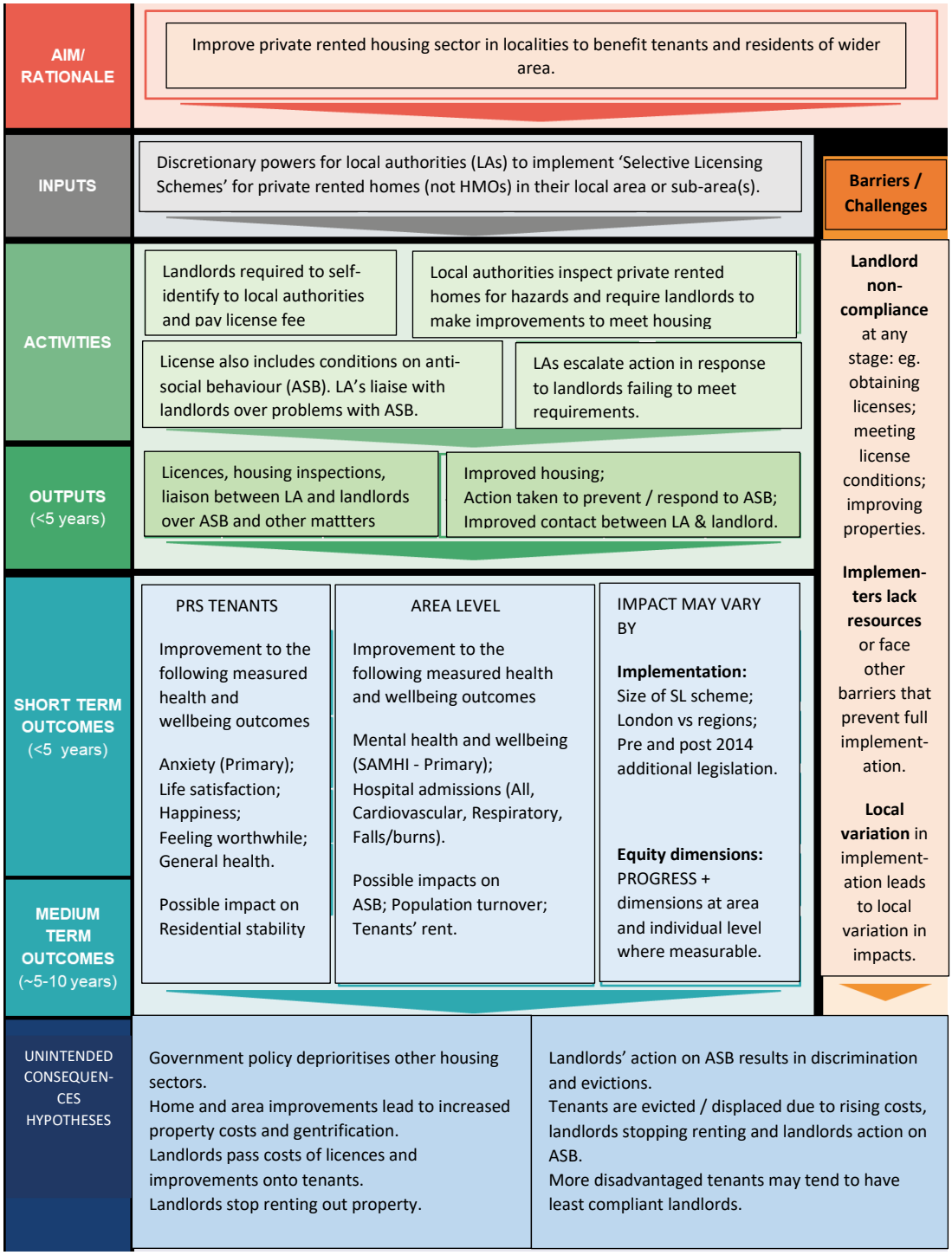

Figure 2 Logic Model: Selective Licensing Schemes

GANTT CHART		2024												2025												
Month:	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J
Governance and Ethics	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
PPI and AG meeetings.																										
Ethics Committee																										
Work Package 1 IMPACT EVALUATION	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
Identification of treatment and control areas																										
Collection of data																										
Fitting of propensity score models & selection of controls																										
Outcome data collection																										
Identification/update of data sources & collection of data																										
Outcome evaluation																										
Development of pre-specified analysis plan																										
Undertake statistical analysis																										
Interpretation and write-up of results																										
Work Package 2 PROCESS EVALUATION	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
Recruitment of stakeholders																										
Refine informed consent & data management protocols																										
Recruit stakeholders																										
Data collection																										
Refine interview guides																										
Conduct implementer/stakeholder interviews and document collection in intervention areas																										
Recruit and conduct landlord and tenant interviews																										
Mapping workshops																										
Follow-up interviews																										
Data analysis & interpretation																										
Work Package 3 ECONOMIC EVALUATION	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
Implementation costs																										
Collection and harmonisation of costs data																										
Analyse cost data																										
Cost-benefit analysis																										
Development of pre-specified analysis plan																										
Undertake statistical analysis																										
Interpretation of results																										
Work Package 4 KNOWLEDGE EXCHANGE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
Develop theory of change & dissemination plans																										
Draft & revise theory of change & dissemination plans																										
Stakeholder workshp-findings, dissemination & theory of change																										
Synthesise & disseminate overall findings																										

Figure 3 Gantt chart for Selective Licencing evaluation.

Appendix II – List of services for tenants

A sheet listing these services will be offered to any tenants who express difficult or distressing experiences.

A. Citizen Advice Bureau (CAB)

Citizens Advice provides free, independent, confidential and impartial advice to everyone on their rights across a range of issues affecting people's lives. CAB is a network with centres across the country. To find out how to make contact see: https://www.citizensadvice.org.uk/

B. Housing support

1. Your local Council has an obligation to provide you with housing support. Here's a link which can tell you your council based on your postal code: https://www.gov.uk/find-local-council.
2. Safer Renting, Cambridge House. Protects tenants who are victimised by criminal landlords by providing specialist advice, advocacy and support. https://ch1889.org/safer-renting
3. "Shelter" is a housing charity in the UK. Free housing advice Telephone helpline: + 44 0808 800 4444. Helpdesk: 0300 330 1234

C. Mental health support

1. Speak to your General Practitioner
2. Telegram channel: https://t.me/PsihologDopomogaWarInUa2022.
3. Telegram channel: https://t.me/psyhelp_Ukraine.
4. Instagram channel: www.instagram.com/psy.for.peace.
5. Psychological support service for Ukrainians website: https://sppu.com.ua/

D. Migrants

Praxis: A charity for migrants and refugees. They provide free immigration and visa advice to ensure you are receiving the support you are entitled to. They also help with housing, homelessness, benefits, health, and welfare. Website: https://www.praxis.org.uk/.

Appendix III – Home interviewer safety protocol

Safety protocol for interviews in participant homes for the "Health impact, process and economic evaluation of selective licensing schemes for private rented housing in England" study

Dr Seguin and/or the appointed Qualitative Research Fellow (RF) may conduct interviews in participant's homes between October 2023 and November 2025.

Dr Seguin and/or the RF will provide their personal mobile phone numbers to the joint study PIs in October 2023. They will provide their mobile numbers to Maureen. A covert emergency word will be decided on prior to interviews in participant homes. Emergency contact details ('next of kin') of Dr Seguin and the RF will be shared with the joint study PIs.

At least 2 days prior to an interview in a participant's home, Dr Seguin and/or the RF will contact the joint PIs to ensure at least one is available on the day of a scheduled visit to receive email updates on the interviewer's whereabouts. If neither are available, Dr Seguin and/or the RF Maureen will identify another colleague at LSHTM to be the contact person regarding the interview. If no colleague is available, then the visit will be rescheduled.

On the day of the visit, Dr Seguin and/or the RF will send an email to the designated PI (or another LSHTM colleague should neither PI be available). The email will contain the start and anticipated end time for the visit, as well as the location. Dr Seguin and/or the RF will carry their mobile phones with them during the visit, and spare portable charger to ensure the phone does not go flat during the visit. Their ringers will be on during the visit. If either Dr Seguin or the RF feels unsafe during the visit, they will ring the designated PI and say the covert emergency word to indicate the need to call the police immediately.

Dr Seguin and/or the RF will send another email to the designated PI from her phone as soon as possible after the visit ends. If the designated PI has not heard from Dr Seguin and/or the RF within an hour of the anticipated end of the visit, they will text and ring Dr Seguin and/or the RF on their personal mobile and email. If they do not answer within a half hour, the designated PI will contact the emergency contact(s) of the interviewer. If they do not know of the interviewer's whereabouts, it is the emergency contact's responsibility to call the police. Should emergency contacts not be reachable, responsibility to call the police falls back to the designated PI.

In addition to this protocol, Dr Seguin and the RF will wear a small personal tracking device, and enable the 'Glympse' app on their phones during visits (including travel to and from the visit location). Both track movements in real time, which will allow emergency contacts to see their whereabouts.

Appendix IV - Topic guide national stakeholder workshop

Interview topic guide (participants =10)

1. Welcome and Introduction: (30 minutes)

- Thank participants for agreeing to attend.
- Introduce study (briefly present findings of London study, then describe national study).
- Describe confidentiality and anonymity procedures; ask everyone to respect each other's views and confidentiality.
- Ask if any questions about the study or maintaining confidentiality
- Obtain written, informed consent and ask if they are happy to be audio recorded.

2. Can you please describe your current role

- *Probe around:*
  - Job title
  - Team/Department
  - Roles – including relevance to selective licensing scheme

EXERCISE 1 (30 minutes)

What is good and bad about the private rented sector? (prompt – is it just a small minority of criminal landlords causing the problems; or are their wider problems affecting a larger part of the sector).

EXERCISE 2 (30 minutes)

How is selective licensing supposed to work:

- What problems does it address? (HOW?)

- What are plausible outcomes? (health, wellbeing, anti-social behaviour; other. For tenants only or area wide?)

- Who benefits / doesn't benefit? (probe around equity dimensions).

EXECISE 3 – hypothesising consequences. (1 hour 30 minutes).
A week before the meeting the participants are given this list of hypotheses. We will now present them again and ask participants views on each of them in turn. First we simply ask each participant to indicate whether or not each hypothesis is 'not valid', 'valid but not a major issue', 'valid and a major issue'. A space will be left for participants to make any further suggestions of possible consequences not covered by the hypotheses.

There will then be a coffee break during which time the facilitators group the hypothesis into (1) widely considered a major issue; (2) widely considered a minor issue; (3) widely considered not to be valid.

In the discussion that follows – roughly 30 minutes is give to each group. It will consider why people have classed it the way they have; and why some participants disagreed with the predominant decision.

A characteristic of some complex systems is that benefits in one part of the system may contribute to harms or problematic outcomes elsewhere in the system. We hypothesise that this applies to the housing system. Some of these unintended consequences can be hypothesised in advance, while others may take us by surprise. What follows is a list of hypothesised unintended consequences we have thought about (we have given each a name, in capitals).

1. POLICY PRIORITY HYPOTHESIS. Some have argued that England's PRS is fundamentally flawed and that people are likely better off (and healthier) owning/mortgaging a home or using social housing. An implication of this argument might be that even if SL does improve the PRS, it risks diverting policymakers away from policies to improve equitable access to the other sectors (e.g. through more affordable ways to buy, and more social housing).
2. AREA IMPROVEMENT HYPOTHESIS. If a place/locality improves, or is widely perceived to have improved, property values could increase. As a result, higher property prices would displace residents who cannot afford those prices.
3. HOME IMPROVEMENT HYPOTHESIS. If individual homes are improved, landlords may want to raise rents to reflect higher market values of improved properties.
4. PASSING COSTS ON TO TENANTS HYPOTHESIS. Landlords may raise rents to cover the costs of any mandated refurbishment and/or the license fee itself.
5. STOP RENTING HYPOTHESIS. Landlords may choose to stop renting property rather than pay for a license or improvements. Taking non-decent homes and poor landlords out of the PRS may be necessary for the sector's improvement but tenants could lose their home.
6. ASB DISCRIMINATION HYPOTHESIS. License conditions that oblige landlords to prevent and reduce ASB may be acted upon in ways that discriminate against certain groups.
7. ASB DISPLACEMENT HYPOTHESIS. Attempts to tackle ASB may displace rather than genuinely reduce ASB if antisocial tenants are obliged to live elsewhere.
8. POLARISATION HYPOTHESIS. Non-compliant landlords may be more likely to let to disadvantaged tenants, who have fewer housing options.
9. NON-COMPLIANCE HYPOTHESIS. Intervention effects may be reduced due to landlord non-compliance at any stage on the pathway to impact (e.g. applying and paying for licenses, meeting conditions of licenses, co-operating with the inspection regime, and refurbishing sub-standard properties).
10. PARTIAL IMPLEMENTATION HYPOTHESIS. Implementers may lack resource (e.g. finance, workforce) or face other barriers that prevent full implementation.
11. LOCAL VARIATION HYPOTHESIS. Local variation in the implementation of SL may lead to local variation in impacts. Local variation can at times be considered positively (e.g. tailoring to local needs) or negatively (e.g. inequities / 'post-code lottery').

Thank participants for their time and ask if they would be interested in further participating in the study.

Appendix V - Topic guide local interpretive workshop

The purpose of this workshop is to present early results back to stakeholders and engage in a dialogue with them about how they might be interpreted. It is intended to inform the conclusions we draw, when writing our findings up. It will not generate data to be analysed as part of a results section of any output: for example, no participant will be quoted in a paper (either anonymously or otherwise).

The format of the workshop is based around the 4 main work packages of the study. In each case we will give a 10-minute presentation, followed by a discussion.

1. Welcome and Introduction: (30 minutes)

- Thank participants for attending
- Introduce study briefly.
- State that we will not be quoting people in any outputs. All contributions are confidential – and should be respected as such by all attending.
- Ask if any questions about the study or maintaining confidentiality

Can you please describe your current role

- *Probe around:*
  - Job title
  - Team/Department
  - Roles – including relevance to selective licensing scheme

SESSION 1. (40 minutes)

Workpackage 1 Findings. We will present initial findings on our quantitative workpackage and invite discussion.

SESSION 2 (40 minutes).

WP2 Findings. We will present initial findings on our qualitative workpackage and invite discussion.

BREAK (30 MINUTES)

SESSION 3 (40 minutes).

WP3 Findings. We will present initial findings on our economic workpackage and invite discussion.

SESSION 4 (40 minutes).

WP4 Findings. We will present the knowledge exchange and dissemination strategy developed in this workpackage and invite discussion.

Thank participants for their time and ask if they would be interested in further participating in the study.

Appendix VI - Topic guide tenant interviews

Pre interview – To determine whether a participant is relevant to the study, a brief chat is needed to establish if the person is one of the following:
1. Implementer – works for a local authority and is involved in the implementation of the licensing scheme (e.g. manages the scheme?, works front line? Or has other role that links with the scheme?: e.g. legal; finances; analytic; public health).
2. Third sector/community – works for an organisation that is connected with private rented housing or with a community group that involves private rented tenants.
3. Landlords – rents property in a selective licensing area (a small scale landlord or medium/large scale property business?). Or provides a property management service for landlords operating in selective licensing areas.
4. Tenants – rents a home in a selective licensing area. To be eligible, the home cannot be a 'House of Multiple Occupancy (HMO)'. Sampling frame includes men and women, people with and without child dependents, white and BAME ethnicity; people on low income or living in disadvantaged area.

1. Introduction

- Thank participant for agreeing to an interview.
- Introduce study
- Describe confidentiality and anonymity procedures
- Ask if any questions about the study or maintaining confidentiality
- Ask if they are happy with the interview being recorded and ask if they have signed the consent form.

We will be clear about this to tenant participants from the start. *You can decline to be involved. At any point. If you take part, you can also decline to answer specific questions. If you feel particularly sensitive about an issue you can choose not to tell us about it. You do not need to justify why.*

We will be clear that we will not tell anyone outside the study they (the tenant) have participated and advise them to either not tell anyone – or be very careful about who they tell. They are not obliged to tell the landlords.

We will also be clear that we are not here to represent the landlord or tenant or anyone else involved with their tenancy – and we cannot personally act to solve any housing problems – as we are not trained to do so, and it would compromise anonymity. We will signpost Safer Renting, Cambridge House for tenant support service.

2. Clarify personal details:

- Name
- Gender
- Ethnicity
- Year of birth
- Do they live alone or with others (how many adults, how many children under 16)?
- Do they live with any non-family members?
- Do they have any disabilities that affect their everyday life?
- Job or role – paid/unpaid/carer/education/job seeking/retired (previous main job?)
- Tell them average household income in their area and ask if they are above or below it?

3. Can you tell me a bit about your housing situation?

a. Length of time in the neighbourhood
b. Rental status
c. Duration of contract
    i. Now
    ii. past 10 years
    iii. any change?
d. How secure you have felt in your property/how frequently you have had to move and reasons for this

4. We'd like to know what you think about the private rented sector as a whole, and your tenancy in particular.

a. First – what do you think about the private rented sector as a whole? What are the good things about it? What are the bad things about it?
b. Now – your current tenancy. What are the good things about it? What are the bad thing about it? (prompt location/neighbourhood, condition of home; cost; relationship with landlord; repairs; threat of eviction; impacts on living arrangements -e.g. pets, visitors, children, pictures on wall). *If tenants want to talk about experiences from previous tenancies they can – especially if the home was in the same area, or it was directly relevant to selective licensing. – the interviewer should judge when to move the conversation on.*
c. Do you just deal with your landlord or do you have others you deal with (e.g. property management company; repair people; inspectors?). Go through each – draw out positive and negative views/experiences.
d. Are you waiting for any repairs?
e. What about the council? Do they get involved at all with the home? (again draw out positive and negative).

5. What do you know about the selective licensing scheme that the local Council are running?

a. Have you heard of landlord licensing? (be prepared to explain what selective licensing is: a 5 year scheme run by the council; landlords pay a fee to the council and inform them of the property they rent out; council inspectors check properties for problems; and often also tell landlords to take more responsibility for anti-social behaviour).
b. Why do you think they are doing it?
c. Do you think tenants will benefit or not – or a mixture - why?
d. Do you council inspectors should visit private rented homes to make sure they meet housing standards?
e. Do you have any personal experiences of the scheme: e.g.
    i. Has anyone provided any information about it?
    ii. Has your home been inspected?
    iii. Has your landlord or property manager responded to licensing in any way that affects you?
        1. has it affected rent?
        2. Has your relationship with landlord changed?
        3. Is landlord concerned about anti-social behaviour?

4. Has you landlord advised you about what to do if inspected?
5. has it affected how secure you feel with your tenancy? (this is primarily about security of tenure – but if the tenant wants to talk about feelings of safety, let them).
6. Has your landlord talked about giving up being a landlord or changing the way they operate as landlords, or avoiding the licensing scheme.

6. What are the impacts of private renting on your health and wellbeing?

- other members of the household?

- any way the licensing scheme contributes to these impacts (for better or worse).

Thank participant for their time and ask if they would be interested in further participating in the study.

Appendix VII - Topic guide landlord interviews

1. Introduction:

- Thank participant for agreeing to an interview
- Introduce study
- Describe confidentiality and anonymity procedures
- Ask if any questions about the study or maintaining confidentiality

Ask if they are happy with the interview being recorded and ask if they have signed the consent form.

2. Can you please tell me what you do in your current role

- *Probe around:*
  - What do you do for a living [is the landlord business your main occupation?]
  - How would you describe you role as a landlord
    - E.g. are you just renting out one or two properties? Do you own small, medium or large letting business? Do you work for a letting business? What do you do?
  - What kind of properties are we talking about? What kind of people are tenants?
  - Is your role to provide a property management service to landlords – rather than owning the rented homes yourself?

3. How would you describe the privately rented housing sector in your area?

- *Probe around:*
  - The kinds of properties
  - The kinds of people who live in them
  - Landlords – are they mainly individuals renting, or larger commercial entities?

4. **Let's talk about what's good and what's not good about the private rented housing sector. I'd like to focus especially on your area's housing, but you can also talk about more general issues if you think they are relevant.**

- *Probe around:*
  - Good things first – what do think is working with respect to the private rented housing sector? [standard of properties, landlords, which kinds of tenant benefit]
  - Now let's move onto the problems
    - Properties, tenants, landlords, other issues? Legal situation? Insurance? [which of these particularly affect your area?]
    - Which kind of people are affected by these problems?
    - Do you think these issues can affect tenants' health and wellbeing? How? Can it affect health in other ways? Landlords? [probe around physical hazards, contagious disease such as covid, stress / mental health]

5. **Now lets talk about the selective licensing scheme: if you had to briefly describe to someone what selective licensing scheme is to someone, what would you say?**

- And how does this scheme work in your area?
- What do you think is the main goal of your area's selective licensing scheme?.
- Thinking about some of the problems with your area's housing market that you mentioned before – in what way do you think the selective licensing scheme tries to address? How? **[prompt through range of problems mentioned previously]**

6. What is it like to be a landlord in an area where this scheme is running?

- What does implementing the scheme involve? What do you have to do? [prompt talk me through the process, how does it start? What happens next, etc]
- Who administers it? Who do you have to deal with?
- What are the costs? What do you think of them?
- Do you think covid has impacted on the scheme – from your perspective? How?

7. How do you think people are responding to the selective licensing scheme at your area?

- Landlords? [compliance with license fee, with giving access, with housing improvements]
- Tenants?
- your area council?
- Have we missed anyone whose response is important? [third sector? – does it have any kind of impact on other parts of the housing market – social rent/owner occupier/multi-occupancy]

8. Who is benefiting and who is not benefitting (how?)

- *Probe around:*
    - Landlords [general, you in particular]
    - Tenants (which kinds of tenants?)
    - your area council? [cost, workload] Others
    - Do you think that there are any potential health benefits? How?
    - Do you think there are any unintended consequences?
    - If you were someone thinking of becoming a landlord for the first time, would you avoid areas that had a selective licensing scheme?

9. Ask their views on the following – if they have any. – ask why and try to distinguish between what <u>they have seen happen</u> and what <u>they think could happen</u>. Both are fine but it's good to tell them apart.

a) Is it leading to private rented homes improving?
b) Landlords / property managers doing this work any differently?
c) Impacts on wider area? (this can include non-PRS homes in area; but also neighbouring communities).
d) Rents (£)
e) Anti-social behaviour
f) Security of tenure / threat of eviction?
g) Exploitation and abuse of tenants
h) Discrimination – certain types of people finding it harder to rent in the area
i) Changes in the kinds of people who live in local private rented property
j) Residents' happiness, wellbeing, or health.

10. If you could abolish the scheme, would you? Why?
If you couldn't abolish the scheme, but you could change it – what changes would you make?

Thank participant for their time and ask if they would be interested in further participating in the study.

Appendix VIII - Topic guide stakeholder interviews

Interview topic guide

1. Introduction:

- Thank participant for agreeing to an interview
- Introduce study
- Describe confidentiality and anonymity procedures
- Ask if any questions about the study or maintaining confidentiality

Ask if they are happy with the interview being recorded and ask if they have signed the consent form.

2. Can you please tell me what you do in your current role

- *Probe around:*
  - Job title
  - Team/Department
  - Range of roles
  - Roles specific to the selective licensing scheme – how long have you been doing it?
  - Proportion of time spent on work related to selective licensing scheme

3. With respect to selective licensing scheme, who do you work with?

- *Probe around:*
  - How work tasks are divided within their team
  - Working with people in other teams / departments at your local authority
  - Landlords
  - Tenants
  - Third sector
  - Others?

4. Let's talk about what's good and what's not good about the private rented housing sector. I'd like to focus especially on your area, but you can also talk about more general issues if you think they are relevant.

- *Probe around:*
  - Good things first – what do think is working with respect to the private rented housing sector? [standard of properties, landlords, which kinds of tenant's benefit]
  - Now let's move onto the problems
    - Properties, tenants, landlords, other issues? Legal situation? Insurance? [which of these particularly affect your area?]
    - Which kind of people are affected by these problems?
    - Do you think these issues can affect tenants' health and wellbeing? How? Can it affect health in other ways? Landlords? [probe around physical hazards, contagious disease such as covid, stress / mental health]

5. Now let's talk about the selective licensing scheme: if you had to briefly describe to someone what selective licensing scheme is to someone, what would you say?

- And how does this scheme work in your area?
- What do you think is the main goal of your area's selective licensing scheme?
- What are the main challenges of administering it?

- Thinking about some of the problems with your area's housing market that you mentioned before – in what way do you think the selective licensing scheme tries to address? How? **[prompt through range of problems mentioned previously]**

6. How do you think people are responding to the selective licensing scheme at your area?

- Landlords? [compliance with license fee, with giving access, with housing improvements – is there any pattern to the kinds of landlords who comply and who doesn't? – e.g. are non-compliers likely to be cheaper properties? Small landlords? Larger organisations? Landlords who rely on property management services?].
- Tenants?
- Your colleagues (inside and outside your immediate team)
- You personally – what do you think of it?
- Have we missed anyone whose response is important? [third sector? – does it have any kind of impact on other parts of the housing market – social rent/owner occupier/multi-occupancy]

7. Who is benefiting and who is not benefitting (how?)

- *Probe around:*
    - Landlords
    - Tenants – any particular kind of tenant doing better or worse than others?
    - your local authority [cost, workload] – *participants can think about this in terms of how it affects the jobs of employees like them; but if they want they can also give their view from an organisational perspective.*
    - Do you think that there are any potential health benefits? How?
    - Do you think there are any unintended consequences?

8. Ask their views on the following – if they have any. – ask why and try to distinguish between what <u>they have seen happen</u> and what <u>they think could happen</u>. Both are fine but it's good to tell them apart.

k) Is it leading to private rented homes improving?
l) Landlords / property managers getting better or worse at their job
m) Impacts on wider area? (this can include non-PRS homes in area; but also neighbouring communities).
n) Rents (£)
o) Anti-social behaviour
p) Security of tenure / threat of eviction?
q) Exploitation and abuse of tenants
r) Discrimination – certain types of people finding it harder to rent in the area
s) Changes in the kinds of people who live in local private rented property
t) Residents' happiness, wellbeing, or health.

Thank participant for their time and ask if they would be interested in further participating in the study.

Appendix IV – Quantitative work packages

Table S1 Selective Licencing schemes 2012-19 by region and area coverage categories. Population estimates based on Census 2011.

Schemes	Number of LSOA11 units							Population
	5-19%	20-39%	40-59%	60-79%	80-99%	100% only	5-100%	
The North (N=32)								
2012_Blackpool	2			3	2		7	9,536
2012_Gateshead	2	2					4	6,580
2013_BlackburnwithDarwen		1		1	1		3	4,861
2013_Salford	3	1					4	7,097
2014_Blackpool	1				5		6	8,881

2014_Burnley	2	5			1		8	11,500
2015_Doncaster	1	3					4	6,898
2015_Hartlepool	2						2	2,738
2015_Liverpool						298	298	465,656
2015_Oldham						12	12	19,429
2015_Rotherham	3	3	1	2	4		13	22,464
2015_Salford	2	3	1		2		8	12,771
2015_Wirral						4	4	5,940
2016_Burnley	3	1					4	6,004
2016_Middlesbrough	1			1	1		3	4,596
2016_Oldham						4	4	7,573
2017_BlackburnwithDarwen	2	2					4	5,494
2017_Manchester		1					1	1,869
2017_Salford	1						1	3,699
2017_Scarborough	1	1		1			3	5,120
2018_Doncaster	2	1		1			4	5,510
2018_Gateshead	1						1	1,770
2018_Hyndburn	3	2	2	1	3		11	18,497
2018_Manchester	2	5	1		1		9	18,460
2018_Sefton						19	19	26,857
2018_Sheffield	9						9	17,213
2019_Blackpool	1				7		8	10,898
2019_Burnley	1		1	1			3	4,372
2019_Gateshead		1					1	1,763
2019_Middlesbrough	3		1		1		5	8,424
2019_Scarborough	1	1		1			3	4,993
2019_Wirral						4	4	6,394
Sub-total	49	33	7	12	28	341	470	743,857
The South (N=14)								
2012_Wolverhampton	2						2	3,040
2013_Bristol						3	3	7,071
2014_Stoke-on-Trent	2	2					4	5,841
2015_Hastings						22	22	37,190
2016_Bristol						14	14	24,352
2016_Peterborough						22	22	42,604
2016_WestLindsey	1			1			2	2,965
2017_Ashfield	1	2					3	5,039
2017_EastStaffordshire						1	1	1,701
2018_Gedling	1	1	1	1	1		5	7,841
2018_Nottingham	6	10	6	8	14	91	135	228,736
2018_Woking	1	1		1	1		4	7,643
2019_GreatYarmouth	1				3		4	7,069
2019_Slough	3	3	1	2	3	2	14	28,356
Sub-total	18	19	8	13	22	155	235	409448
London (N=15)								
2012_Newham						155	155	293,736
2014_BarkingandDagenham						110	110	187,029
2015_Brent						23	23	47,632
2015_Croydon						220	220	364,815
2015_Harrow						7	7	11,756
2015_WalthamForest						144	144	259,742
2016_Harrow						6	6	11,483
2016_TowerHamlets						22	22	38,717
2017_Ealing						43	43	77,337
2017_Redbridge					2	14	16	29,203
2018_Bexley					11	2	13	23,798
2018_Brent					4	39	43	78,160
2018_Hackney				1		21	22	37,890
2018_Harrow						14	14	24,646
2018_Redbridge	1				51	40	92	168,077
Sub-total	1	0	0	1	68	860	930	1,654,021
ENGLAND TOTAL	68	52	15	26	118	1,356	1,635	2,807,326

Table S2 Selective Licencing Master file variables.

Number	Variable	Type	Value label	Variable label
1	lsoa11	str9		LSOA11CD
2	la_name	str22		LA_NAME
3	tyear	float		Year first treated
4	cat	float	cat	SL classification
5	lsoa_area_pc	float		(max) lsoa_area_pc
6	gor	str9		Government Region (Aug 2016)
7	oslauanm	str36		Local Authority name (Aug 2016)

8	nsl	float	nsl	Super Region: North/South/London
9	lat	float		Mean latitude of live small user postcodes (Aug 2016)
10	lon	float		Mean longitude of live small user postcodes (Aug 2016)
11	tla	str24		SL scheme 20YY+LA Name
12	cover	float	cover	Treatment area coverage category
13	syear2012	float		Spillover 2012
14	syear2013	float		Spillover 2013
15	syear2014	float		Spillover 2014
16	syear2015	float		Spillover 2015
17	syear2016	float		Spillover 2016
18	syear2017	float		Spillover 2017
19	syear2018	float		Spillover 2018
20	syear2019	float		Spillover 2019
21	nspill	float		Number of times a spillover
22	syear	float		Year first spillover
23	age0_15	float		Aged 0-15yr (2011)
24	age16_59	float		Aged 16-59yr (2011)
25	age75	float		Aged 75+yr (2011)
26	incomescorerate	float		Income Score (rate)
27	hh_privaterent	float		Household tenure: private rented (Census2011)
28	hh_poorcond	double		Housing in poor condition indicator
29	hh_overcrowd	double		Household overcrowding indicator
30	hh_afford	double		Housing affordability indicator
31	nonwhite	float		Non-White (Census2011)
32	prewar	float		Built before 1945 (most frequent)
33	urban	float		Urban 2011 (DEFRA)
34	cfw	float		Matched treatment control frequency weight
35	scfw	byte		Matched spillover control frequency weight
36	treated	float		Treatment allocation
37	prspop11	int		Census 2011 private rental sector tenants
38	pop11	int		Census 2011 usual residents
39	tla_p	float		Scheme population% (Census 2011)

Value label cat
- 0 Untreated
- 1 Treated
- 2 Matched control
- 8 Spillover single
- 9 Spillover multiple
- 97 Street-based schemes
- 98 Pre-treated 2007-11
- 99 Future treated 2020-21

Value label nsl
- 1 North
- 2 South
- 3 London

Value label cover
- 5 5-49%
- 50 50-99%
- 100 100%

Table S3 Sequential imputation of missing dwelling construction era information by 2011 Lower layer Super Output Area (LSOA11). Missing values replaced with the non-missing value of the geodetically nearest neighbour (1-4 neighbours).

Category	LSOA11			Mean distance (km)
	N	%	Cumulative %	
Non-missing singular	30840	93.90	93.90	N/A
Non-missing with ties	970	2.95	96.85	N/A
1st neighbour imputed	884	2.69	99.54	0.83
2nd neighbour imputed	137	0.42	99.96	1.06
3rd neighbour imputed	10	0.03	99.99	0.78
4th neighbour imputed	3	0.01	100	0.88

Total	32,844	100

Table S4 Selective Licencing treatment propensity-score matching logit regression output by super-region.

Covariates	Individual co-variates			Multiple co-variates		
	OR	P	95% CI	OR	P	95% CI
THE NORTH; Treated units=470; N=7,725; Pseudo-R^2=.236						
Age 0-15 years	**-2.08**	.031	-3.97;-.19	**-12.15**	<.001	-14.97;-9.53
Age 16-59 years	**6.44**	<.001	5.52;7.37	**6.59**	<.001	4.38;8.85
Ln(Income deprivation)	**1.28**	<.001	1.12;1.44	**2.47**	<.001	2.15;2.83
Ln(Private rental)	**1.28**	<.001	1.14;1.42	.39	.004	.12;.65
Unaffordability	**.36**	<.001	.31;.42	.02	.739	-.10;.14
Ln(Poor housing cond.)	**2.19**	<.001	1.91;2.47	**.84**	.001	.34;1.25
Ln(Overcrowding)	**.89**	<.001	.76;1.01	**-1.44**	<.001	-1.75;-1.12
Ln(Non-White)	**.46**	<.001	.39;.54	**.54**	<.001	.41;.67
Pre-1945 construction	**1.36**	<.001	1.14;1.57	**.59**	<.001	.31;.87
THE SOUTH; Treated units=235; N=13,981; Pseudo-R^2=.259						
Age 0-15 years	-1.13	.409	-3.81;1.55	**-6.74**	<.001	-10.24;-3.24
Age 16-59 years	**9.49**	<.001	8.31;10.68	**6.44**	<.001	3.50;9.38
Ln(Income deprivation)	**1.42**	<.001	1.19;1.64	**2.18**	<.001	1.77;2.59
Ln(Private rental)	**1.71**	<.001	1.49;1.92	**1.19**	<.001	.76;1.61
Unaffordability	**.46**	<.001	.38;.53	-.10	.177	-.25;.05
Ln(Poor housing cond.)	**2.68**	<.001	2.31;3.05	.16	.576	-.40;.71
Ln(Overcrowding)	**1.42**	<.001	1.23;1.60	**-1.19**	<.001	-1.60;-.78
Ln(Non-White)	**1.15**	<.001	1.01;1.28	**1.02**	<.001	.83;1.22
Pre-1945 construction	**1.23**	<.001	.96;1.50	-.07	.702	-.43;.29
LONDON; Treated units=930; N=4,109; Pseudo-R^2=.196						
Age 0-15 years	**13.82**	<.001	12.15;15.50	**10.80**	<.001	8.05;13.54
Age 16-59 years	-.65	.208	-1.67;.36	2.00	.152	-.73;4.73
Ln(Income deprivation)	**.97**	<.001	.84;1.10	**1.14**	<.001	.84;1.44
Ln(Private rental)	**.31**	<.001	.19;.42	**.78**	<.001	.51;1.05
Unaffordability	**.38**	<.001	.33;.43	**-.14**	.013	-.25;-.03
Ln(Poor housing cond.)	.09	.555	-.20;.37	.46	.059	-.02;.93
Ln(Overcrowding)	**.57**	<.001	.46;.69	**-1.68**	<.001	-2.07;-1.29
Ln(Non-White)	**1.86**	<.001	1.69;2.04	**2.19**	<.001	1.92;2.47
Pre-1945 construction	**.29**	.001	.13;.46	**.43**	<.001	.22;.64

Table S5 Baseline characteristics for Spillovers, Never-treated, and propensity score matched control areas (1 treated:3 controls) with replacement. Number of standardised 2011 Lower Layer Super Output Area (LSOA11). Balance was tested with a Wilcoxon rank-sum test (t-test for comparison). Binary outcome (Pre-1945 construction) tested with a Chi-square test.

A Matching variables	B Spillovers	C Never-Treated	D Matched Controls	E Std. dif. (B-D)
THE NORTH	N=321	N=8,528	N=963 (863 unique)	
Age 0-15 years	.20	.18	.20	.01
Age 16-59 years	.60	.58	.60	.02
Ln(Income deprivation)	-1.63	-2.11	-1.65	.02
Ln(Private rental)	-1.88	-2.20	-1.91	.06
Unaffordability	.32	-.63	.22	.04
Ln(Poor housing cond.)	-1.43	-1.57	-1.43	<.01
Ln(Overcrowding)	-2.74	-3.18	-2.77	.03
Ln(Non-White)	-2.67	-3.35	-2.67	.01
Pre-1945 construction	.67	.47	.66	.01
THE SOUTH	N=236	N=18,046	N=750 (665 unique)	
Age 0-15 years	.20	.19	.20	-.04
Age 16-59 years	.59	.57	.60	-.07
Ln(Income deprivation)	-2.02	-2.33	-1.97	-.07

Ln(Private rental)	-1.90	-2.11	-1.90	.01
Unaffordability	.05	-.25	.19	-.07
Ln(Poor housing cond.)	-1.55	-1.53	-1.55	<-.01
Ln(Overcrowding)	-2.74	-3.05	-2.66	-.10
Ln(Non-White)	-2.08	-3.01	-2.03	-.05
Pre-1945 construction	.43	.40	.43	<.01
LONDON	N=286	N=3,187	N=858 (666 unique)	
Age 0-15 years	.21	.19	.21	.02
Age 16-59 years	.63	.64	.63	.02
Ln(Income deprivation)	-1.79	-2.12	-1.81	.03
Ln(Private rental)	-1.64	-1.63	-1.64	<-.01
Unaffordability	2.34	1.55	2.33	.01
Ln(Poor housing cond.)	-1.57	-1.53	-1.57	<-.01
Ln(Overcrowding)	-1.67	-1.87	-1.68	<.01
Ln(Non-White)	-.85	-1.25	-.84	-.01
Pre-1945 construction	.66	.70	.66	.01

Data sources: Indices of Multiple Deprivation 2015 [54]; Census 2011 [51]. Abbreviation: Households (hh), Standardised distance (Std. dif.). Regions were defined as The North, The South, and London.

Table S6 Selective Licencing spillover propensity-score matching logit regression output by super-region.

Covariates	**Individual co-variates**			**Multiple co-variates**		
	OR	**P**	**95% CI**	**OR**	**P**	**95% CI**
THE NORTH; Spillover units=321; N=8,849; Pseudo-R^2=.090						
Age 0-15 years	**5.55**	<.001	3.36;7.75	-1.89	.210	-4.84;1.07
Age 16-59 years	**4.41**	<.001	3.22;5.60	**4.82**	<.001	2.33;7.30
Ln(Income deprivation)	**.86**	<.001	.69;1.03	**1.52**	<.001	1.17;1.87
Ln(Private rental)	**.74**	<.001	.58;.91	.03	.837	-.26;.32
Unaffordability	**.23**	<.001	.18;.29	**-.19**	.002	-.31;-.07
Ln(Poor housing cond.)	**.78**	<.001	.52;1.04	**.53**	.020	.08;.97
Ln(Overcrowding)	**.70**	<.001	.56;.84	**-.46**	.007	-.80;-.13
Ln(Non-White)	**.45**	<.001	.36;.53	**.40**	<.001	.27;.54
Pre-1945 construction	**.82**	<.001	.58;1.05	**.36**	.016	.07;.65
THE SOUTH; Spillover units=236; N=18,282; Pseudo-R^2=.091						
Age 0-15 years	**5.28**	<.001	2.58;7.98	-3.54	.026	-6.64;-.43
Age 16-59 years	**3.63**	<.001	210;5.17	**-2.99**	.032	-5.73;-.25
Ln(Income deprivation)	**.63**	<.001	.44;.82	**1.18**	<.001	.84;1.53
Ln(Private rental)	**.56**	<.001	.35;.77	**.67**	<.001	.32;1.02
Unaffordability	**.11**	.005	.03;.19	**-.31**	<.001	-.44;-.17
Ln(Poor housing cond.)	-.06	.667	-.34;.22	-.42	.052	-.85;>.01
Ln(Overcrowding)	**.51**	<.001	.35;.68	**-.51**	.007	-.89;-.14
Ln(Non-White)	**.73**	<.001	.61;.84	**.92**	<.001	.76;1.07
Pre-1945 construction	.15	.269	-.11;.41	.04	.903	-.36;.32
LONDON; Spillover units=286; N=3,473; Pseudo-R^2=.086						
Age 0-15 years	**8.75**	<.001	6.28;11.23	.70	.728	-3.23;4.63
Age 16-59 years	**-1.88**	.028	-3.55;-.20	-3.66	.058	-7.43;.12
Ln(Income deprivation)	**.80**	<.001	.59;1.00	**.98**	<.001	.54;1.42
Ln(Private rental)	-.01	.908	-.20;.18	**.49**	.016	.09;.88
Unaffordability	**.32**	<.001	.24;.40	-.09	.277	-.26;.08
Ln(Poor housing cond.)	**-.66**	.009	-1.15;-.17	-.49	.193	-1.22;.25
Ln(Overcrowding)	**.39**	<.001	.21;.57	**-.78**	.007	-1.35;-.22
Ln(Non-White)	**1.29**	<.001	1.04;1.55	**1.43**	<.001	1.05;1.81
Pre-1945 construction	-.18	.160	-.44;.07	.12	.428	-.18;.43

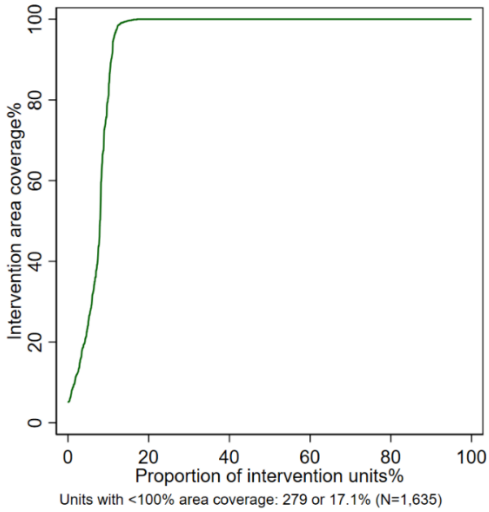

Figure S1 Selective Licensing Intervention units 2012-19 (2011 Lower layer Super Output Area) ordered according to intervention area coverage.

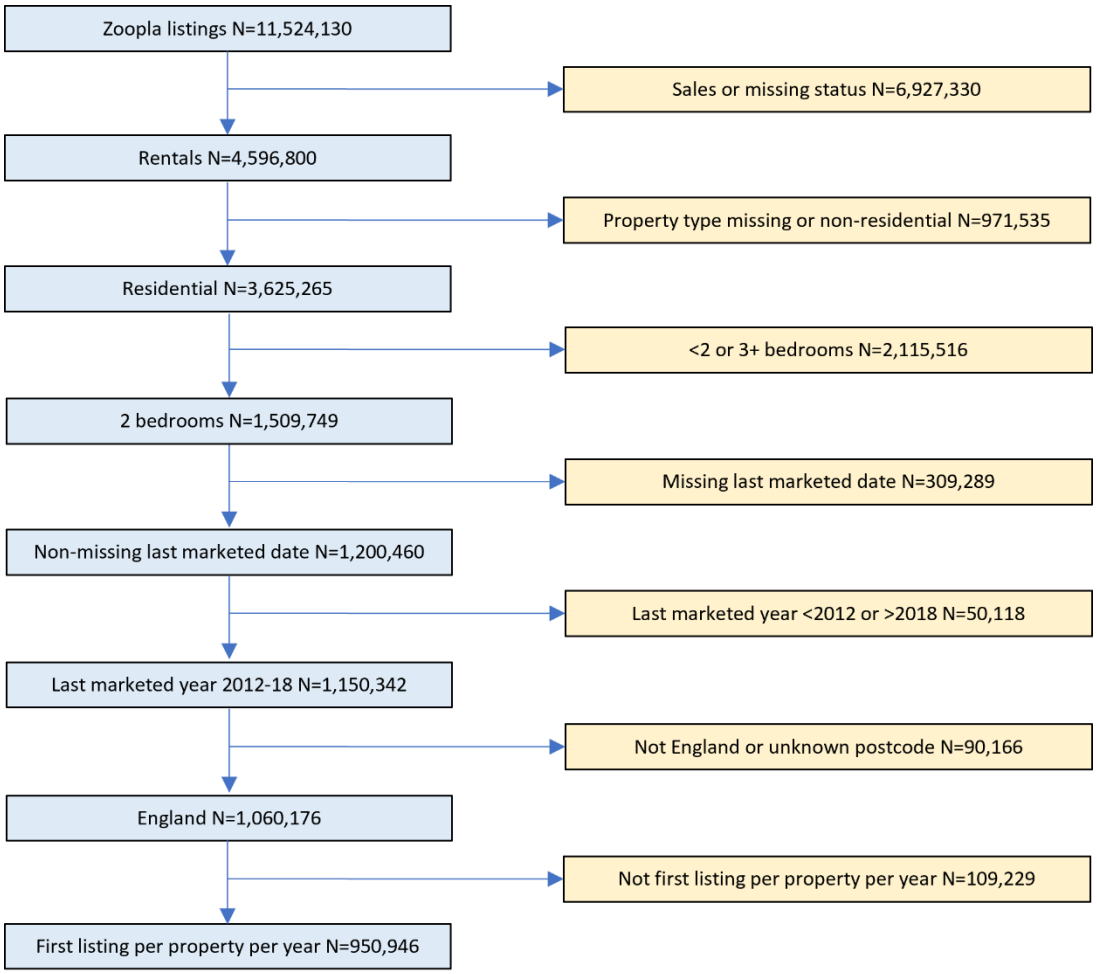

Figure S2 Flow diagram for Zoopla Generation 1 data. Non-residential categories: Business park, Chalet, Equestrian property, Hotel/guest house, Houseboat, Industrial, Land, Leisure/hospitality, Light industrial, Mobile/park home, Office, Parking/garage, Pub/bar, Restaurant/café, Retail premises, Warehouse.