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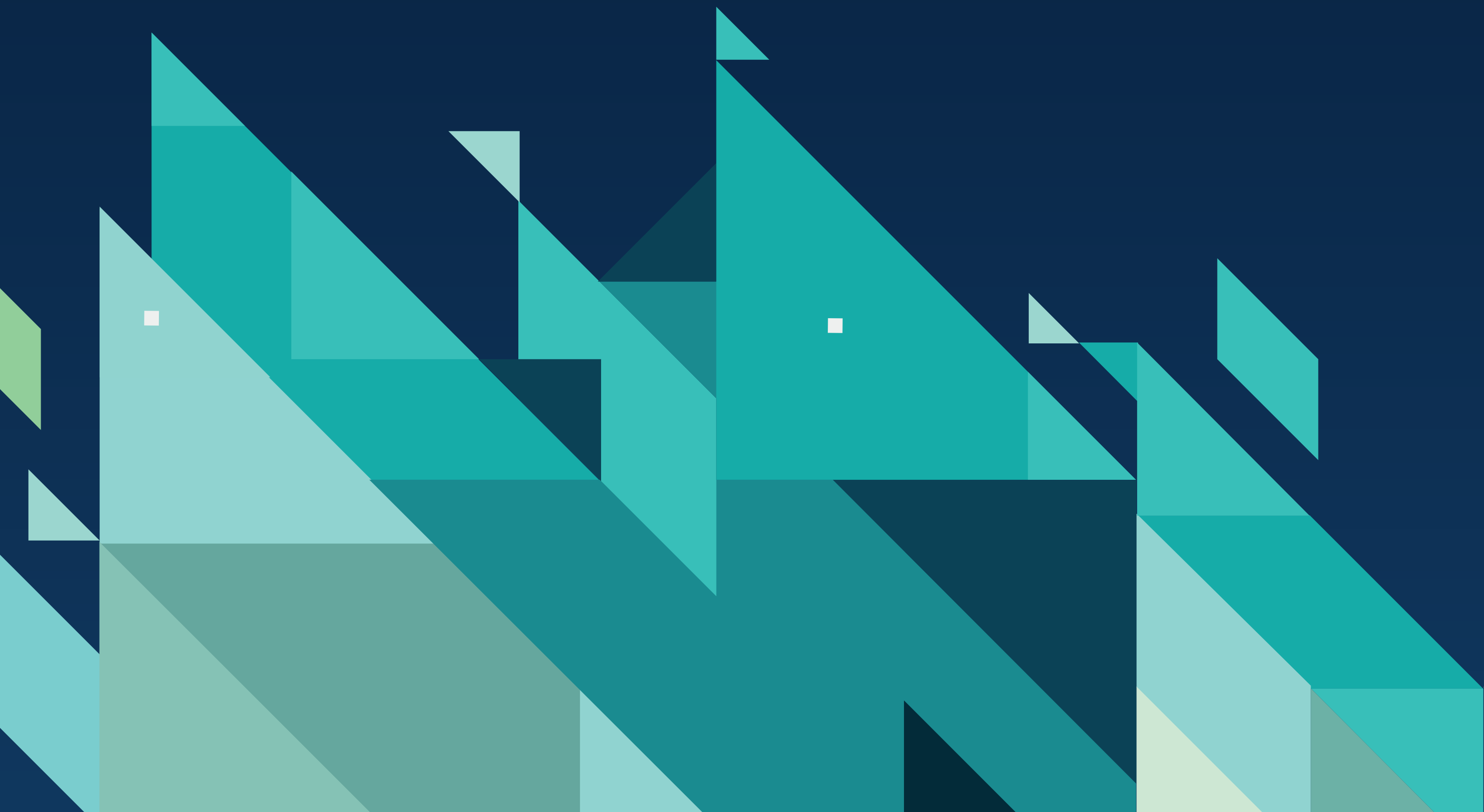
Exploring investment requirements for energy efficiency upgrades in the private rental sector

JANEZ KREN, EOIN KENNY, CONOR O'TOOLE, EVA SHIEL AND RACHEL SLAYMAKER



EXPLORING INVESTMENT REQUIREMENTS FOR ENERGY EFFICIENCY UPGRADES IN THE PRIVATE RENTAL SECTOR

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This report has been accepted for publication by the Institute, which does not itself take institutional policy positions. The report has been peer reviewed prior to publication. The authors are solely responsible for the content and the views expressed.

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LIST OF ABBREVIATIONS

AHB	Approved housing bodies
AIC	Akaike information criterion
BIC	Bayesian information criterion
BER	Building energy rating
CSO	Central Statistics Office
DSR	Debt–service ratio
HAP	Housing Assistance Payment
HFCS	Household Finance and Consumption Survey
LASHU	Local Authorities Social Housing Upgrade
MPRN	Meter point reference number
OSS	One Stop Shop
PRS	Private rental sector
RAS	Rental Accommodation Scheme
RTB	Residential Tenancies Board
SBCI	Strategic Banking Corporation of Ireland
SEAI	Sustainable Energy Authority of Ireland
SILC	Survey on Income and Living Conditions

EXECUTIVE SUMMARY

Improving the energy efficiency of the residential housing sector represents a key challenge in meeting Ireland's carbon reduction targets. While challenges exist across the sector in terms of incentivising upgrades, these difficulties are more pronounced in the rental sector, which suffers from the longstanding split incentive issue between landlords and tenants. Split incentive refers to the situation whereby landlords face the investment cost while tenants receive the benefit in terms of energy efficiency. However, to inform any policy response, it is important to quantify the scale of the investment requirements and to consider the profile of landlords and their financial capacity to make the required upgrades.

In this report, our research objectives are three-fold. First, we use a range of micro datasets to explore the energy-efficiency profile of the housing stock in the residential private rental sector (PRS). We draw on the Residential Tenancies Board (RTB) annual registrations data and the Sustainable Energy Authority of Ireland (SEAI) building energy rating (BER) research dataset. Second, we use unique micro data on investments on social housing upgrades and SEAI grants to cost the scale of upgrading the stock using a range of scenarios. Third, we focus on household landlords in Ireland, and explore their ability to finance investments in energy efficiency in rented dwellings using micro data from the Central Statistics Office's (CSO) Household Finance and Consumption Survey (HFCS). The key findings from the analysis are presented below.

MAIN FINDINGS FROM INVESTMENT NEEDS ASSESSMENT

- We find that approximately four-in-five rented dwellings have a BER below B at present (> 125 kWh/m2/yr in CO_2 emissions). Using weights based on the Census, this equates to approximately 240,000-260,000 rental properties (out of a total of 330,000 dwellings in the PRS in 2022). The majority of properties in this group have a D (c. 24%) or C rating (c. 38%). Approximately 45,000 of rental properties (14% to 19% of the total) have very low energy efficiency, ranking E, F or G.

- We use data from two sources (the SEAI One Stop Shop (OSS) Programme and the Local Authority Retrofit Programme) to explore the cost of renovating the existing private rental stock to approximate a B1–B2 rating. The average cost of upgrades runs from €43k for a G rated property to just under €30k for a C rated property.

- Across all properties, and using a range of estimates, the aggregate cost of upgrading the housing stock of residential rental properties (that are not heritage structures) is estimated to be between €7bn and €8bn in 2023 prices.

The wide variation in the estimates reflects our use of a range of datasets and scenarios to provide sufficient robustness checks.

SUMMARY OF FINDINGS ON THE FINANCIAL CAPACITY OF HOUSEHOLD LANDLORDS

Ireland's rental sector is predominantly made up of household landlords who own fewer than three rental properties. Understanding the financial capacity of these landlords requires an assessment of their overall financial and demographic situation. We run a number of scenarios that test the financial capacity of household landlords to make investments. We find:

- Nearly one-in-two landlords would have insufficient own funds to cover a €25k investment, while only 14 per cent could fund a €100k investment out of their own funds;

- The typical financing gap (the difference between savings and the level of investment) increased from €14k in the €25k investment scenario to over €73k in the largest investment scenario;

- These scenarios assume a full use of all internal funds by the landlord, which is a hypothetical and unlikely scenario; i.e. households are unlikely to commit all their liquid resources to investing in the retrofit of buy-to-let properties.

MAIN OVERALL FINDINGS

These findings indicate that considerable challenges are present for Irish household landlords, in relation to investing in carbon-/energy-saving technologies.

- First, households face a trade off in terms of the risk–reward benefit of any investment. For older household landlords, the time horizon to recoup savings from their properties is lessened as their economic lifecycles are likely to be shorter in duration; this provides fewer years to recoup the investment cost. However, this must be considered against any allowable increase in the rent if the upgrades occur.

- Second, on the credit supply side, some landlords are unlikely to be able to obtain sufficient finance from commercial market sources (due to the repayment capacity) to cover the investment gaps if they had investment opportunities they wished to explore. Alternative financing is available through the Strategic Banking Corporation of Ireland's (SBCI) Home Retrofit Loan Scheme, which can lower the cost of funding required for investments that fall within its remit.

- Third, on the demand side, these landlords are likely to face considerable competing needs for their incomes and financial resources, including meeting day-to-day expenditures or retrofitting their own main residential dwelling. Willingness to invest may be an ongoing challenge.

These findings point to complex challenges if landlords are going to engage in energy efficiency upgrades. Difficulties with split incentives, the age and financial profile of landlords, and their investment appetite together create an extremely uncertain investment climate. Rising interest rates by global central banks as part of the snapback in monetary policy due to high inflation is also likely to: raise the cost of financing investment in energy efficiency; present viability challenges; and further enhance split incentive issues. However, lower-than-market-cost loans from the SBCI backed scheme may help alleviate some credit access issues.

From a policy perspective, the introduction of minimum standards may have a number of impacts. For example, on the positive side, such standards can act as a lever to elicit investments and raise the overall energy efficiency of the sector. Conversely, they may lead to a reappraisal of the attractiveness of investment, and even divestment, among some owners. Unlike in many other rent control legislations internationally, landlords in Rent Pressure Zone areas in Ireland are eligible for exemption from the standard rent increase limits if the rented dwelling undertook a substantial renovation. This includes the upgrades in energy efficiency. This is an important factor in terms of incentivising landlord to make upgrades. In conclusion, these factors, alongside the numerous other relevant policies, grants and supports available (which are outside the scope of this research), will need to be considered in the context of overall financing gaps and willingness to invest. In particular, future research should focus on the split incentive and how it might manifest in an Irish context, and should explore the sensitivity of investment to policy supports.

CHAPTER 1

Introduction

The Government of Ireland Climate Action Plan 2021 set a goal for a reduction in greenhouse gas emissions of 51 per cent over the period 2021–2030 (Government of Ireland, 2021). A critical part of this emissions reduction strategy is securing a more energy efficient built environment for both the commercial and the residential sector. On the residential side, the contribution to total greenhouse gas emissions in 2018 was 11.2 per cent, falling to 9 per cent in 2022, which indicates the benefits that can be accrued from a focus on the sectors' performance. Improving energy efficiency in the residential housing stock is an important component of the transition to a low carbon economy in Ireland, and the aim for the sector is to reduce emissions considerably from the observed 7 megatonnes of carbon dioxide equivalent ($MtCO_2$) in 2018 and 6.1 $MtCO_2$ in 2022 (Government of Ireland, 2024).

To meet these targets, there is a major energy efficiency upgrade requirement to bring Irish homes towards a building energy rating (BER) of B2 standard or better, and to improve the energy efficiency of the rest of the housing stock. Within this context, the National Residential Retrofit Plan aims to achieve the retrofitting of 500,000 homes to a BER of B2/cost-optimal or carbon equivalent and the installation of 400,000 heat pumps in existing homes to replace older, less efficient heating systems by end-2030.

While this is a challenge for the residential housing sector as a whole, the requirement is even more acute for the built environment in the rental sector. Rental housing has a higher share of lower efficiency properties (Petrov and Ryan, 2021) and faces issues such as split incentives, whereby landlords must invest but may not directly experience the gains from investment in the short run. Over and above the split incentive issues, an increasing number of households are living in the private renter sector. The most recent Census of Population for Ireland 2022 indicated the total number of occupied rental properties in the private sector was 330,632, an increase of over 7 per cent from the previous 2016 Census. Thus, the combination of two factors regarding this sector – its notable barriers to investment and the fact that it makes up an increasing share of overall housing provision – suggests considerable challenges in attempting to meet the climate targets set for this residential housing market cohort.

To understand the scale of the challenge facing the rental housing sector, we attempt three exercises in this report. Firstly, we aim to provide a profile of the sector in terms of its measured energy efficiency. Secondly, we aim to provide some cost estimates (both at a property level and an aggregate level) as to what the investment cost would be to upgrade the stock to a higher energy efficiency level. Finally, we explore whether household landlords,[1] who make up a large proportion of the owners in the sector, have the financial capacity to make these investments in energy efficiency. More specifically, we attempt to answer the following questions:

- What is the current energy-efficiency profile of the rental sector in terms of the dwelling types, locations and properties?
- What level(s) of investment would be required to increase the above housing stock to more energy efficient levels?
- Do household landlords have the financial capacity to make investments in energy efficiency?

For the final question, our focus is on household landlords for two reasons: first, they make up a large proportion of the market; and second, they are more likely to face barriers to investment relative to large institutional landlords. For example, larger, commercial landlords face different financing conditions and financial capacity than smaller household landlords. They also face differing incentives around the payback period and rate of return on any residential investment activity. However, the rental sector has many household landlords who have few properties and may not have sufficient wealth to finance the upgrade plans. Understanding the profile and structure of these landlords is critically important in terms of understanding the sector's investment outlook and capacity. Our assessment of the investment capacity of these landlords is done from a financial perspective and does not take into consideration the availability of existing policy supports of which they can avail.

Addressing these questions is hindered by several notable data gaps. First, there is no national database of all rental properties that would include verified BER certificates and would provide detailed information on the various property characteristics needed to explore any potential upgrades. Second, information is required on the typical costs of energy efficiency upgrades and the corresponding change in the BER.

To bridge these data gaps, we draw from a number of different datasets both as core analytical tools and also as secondary robustness checks. To profile the energy efficiency of the sector, we firstly use data from the annual and new tenancies registrations from the Residential Tenancies Board (RTB) for the 12-month period of April 2022 to April 2023. Information on new tenancies has been collected since 2007. However, annual registration of all tenancies in Ireland has been a legal requirement since April 2022. More details on this dataset can be found in

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[1] A household landlord is defined as a household that owns a residential property other than their main household residence and rents out or leases that property. Note this does not include institutional landlords.

Slaymaker and Shiel (2023). In this dataset, we obtain self-reported BER certificate values, which are available for approximately half of the properties. The overall dataset size is approximately 190,000 observations.[2] The dataset also contains selected information on the dwellings such as their type (semi-detached, detached, terrace, apartment) as well as floor area and location.

As these data only contain a self-reported BER, we require a robustness check to cross-examine the self-reported information. For these purposes, we also draw on the Sustainable Energy Authority of Ireland (SEAI) property-level BER Research Tool database, which contains a large range of information on the energy efficiency of BER-assessed properties. From these data, a subset can be extracted of the properties that have had a BER assessment for the purposes of renting the property on the private market. For both the RTB and SEAI datasets, we move from the sample to a population estimate by taking a set of weights by county and property type from the Irish Census of Population 2022. Additionally, we estimate the number of rental properties in protected heritage buildings. These buildings are exempt from BER ratings and are excluded from the cost estimates.

To understand the cost of upgrading individual properties in Ireland, we combine two datasets. First, a database from the Department of Housing, Local Government and Heritage contains information on the investment expenditures on upgrading properties owned by the local authorities as part of their social housing stock. This Local Authorities Social Housing Upgrade (LASHU) dataset contains detailed information on the property, including housing type, information on the upgrade and, critically, the BER ratings before and after the upgrade. Our dataset contains 390 upgrades across 16 local authorities for the year 2022. Second, we use a dataset, provided by the SEAI, that includes a sample of properties that have received grants for the efficiency upgrades from the SEAI's One Stop Shop (OSS) services. This dataset includes 1,068 upgrades by both privately-owned properties and properties of the approved housing bodies (AHBs).

From the combined LASHU and OSS data, we estimate the average cost of efficiency upgrades per dwelling with multiple regression models. We use the post-upgrade B ratings as the upgrade scenario. The upgrade costs are then modelled as a function of pre-upgrade BER, location, dwelling type and dwelling size. The aggregate cost estimates are obtained by combining per-dwelling costs estimates with the population estimates of the rental housings stock. Finally, our assessment of the financial capacity of household landlords is undertaken using the Central Statistic Offices (CSO) Household Finance and Consumption Survey (HFCS).

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[2] There are a number of reasons why landlords may not report their BER, such as lack of awareness of the information, accidental missing data or possible other strategic reasons. We do not have any data that provides insight into these factors at present. These data are described in more detail in Section 3.

The paper is structured as follows. Chapter 2 presents the international literature and Irish context. Chapter 3 profiles the energy efficiency of the sector. Chapter 4 considers investment requirements for upgrades. Chapter 5 explores the financial capacity of household landlords. Chapter 6 concludes.

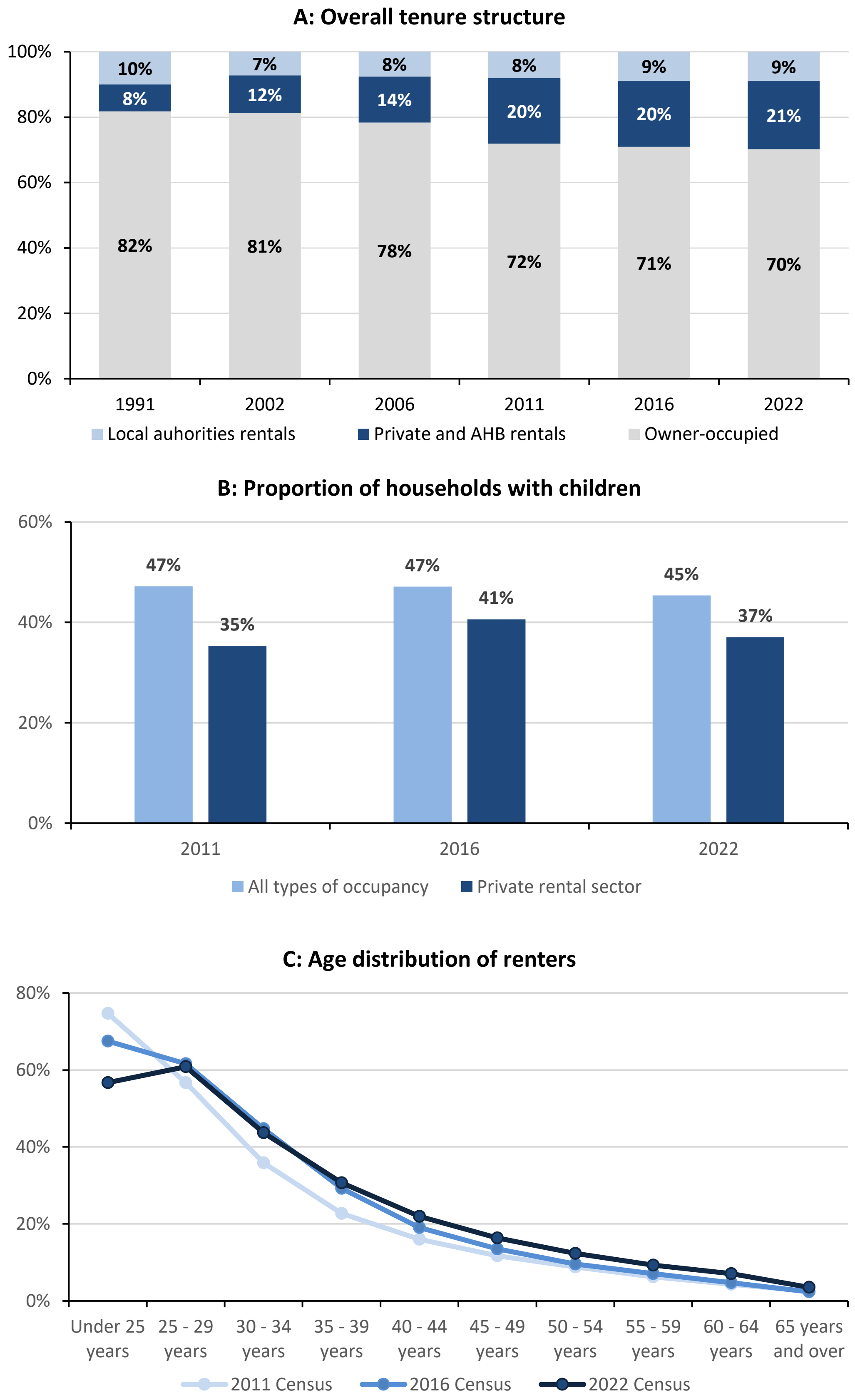
CHAPTER 2

Background and context

2.1 THE IRISH HOUSING MARKET

In line with the challenges in the broader housing market in Ireland, the private rental sector (PRS) has been providing a growing share of housing in the past number of years. Figure 2.1 presents the tenure structure of Irish households from the Census from 1991 onwards. The figure presents three groups of households: those in local authority housing; private renting households, which include rentals from approved housing bodies (AHBs); and owner-occupied housing. The share of owner-occupied housing has declined from a high of 82 per cent in 1991 to 70 per cent in 2022. This decline has seen a corresponding increase in the share of private rental properties. Two further insights from the Census data are important in terms of contextualising the changing role of the PRS: Figure 2.1 also shows the proportion of households with children, overall and for households living in the PRS, as well as the proportion of households in the PRS across the age distribution of the household. The largest increases in the proportion of renters across the age distribution are occurring among those in the 'family formation' age group (30–44 years). The rate is also increasing among older renters (65+ years). Furthermore, the proportion of households with children in the rental sector increased between 2011 and 2022. This changing demographic structure may present greater challenges in terms of the energy efficiency requirements of the dwellings over time.

FIGURE 2.1 TENURE STRUCTURE OF IRISH HOUSEHOLDS FROM CENSUS DATA



Source: CSO Census data.

Notes: Owner-occupied housing includes those owned either by mortgage or outright. Dwellings occupied free of rent and those for whom ‘not stated’ is recorded regarding the nature of the occupancy are excluded.

A number of research papers have studied these dynamics. McQuinn et al. (2021) and Slaymaker et al. (2022) have both noted that the challenges in terms of homeownership have been due to house prices outstripping income growth for young households and housing supply remaining well below the level needed for standstill household formation. Indeed, Slaymaker et al. (2022) indicate that a structurally lower rate of homeownership is likely to continue, with more households remaining in rented accommodation throughout their lifecycle.

From the perspective of this research, the critical point is that a greater share of the housing stock is now for rental accommodation. For this reason, the challenge of managing the split incentive in an energy efficiency context is even greater than it would have been historically.

A further complication arises due to the quality of the housing stock in the rental sector in Ireland. The proportion of properties with low energy efficiency and a very high retrofit requirement is higher than that for the owner-occupied sector (Petrov and Ryan, 2021). This is due to the nature of the housing stock in the PRS, which tends to be older and to have a lower building energy rating (BER). Figure 2.2 presents the structure of the BER ratings for properties in different groups of the rental sector from the Central Statistics Office (CSO) report, *Rental market in Ireland 2021*. These data split the sector into different groups of the market based on BER status and the type of landlord. It must be noted that these data are taken from the Residential Tenancies Board (RTB) residential tenancies registration dataset, which at that time covered only new registrations and Part 4 renewals. It does not therefore provide an assessment of the entirety of the rental housing stock; rather, it oversamples properties new to the market (including new construction) and those that turn over on a regular basis.

The groupings presented are: approved housing bodies (AHBs), Housing Assistance Payment (HAP) recipients, Rent Supplement recipients,[3] local authority properties, PRS housing with private individual household landlords and PRS housing with non-household owners (such as investment funds and other institutional landlords). It is very clear that the individual landlord owned properties, as well as those inhabited by HAP and Rent Supplement recipients, who also live in PRS accommodation, have the highest share of low BER properties; at least 50 per cent of the properties in these groupings are below a C rating. Both AHB properties and those in the non-household PRS sector have a higher share of A–C BER-rated properties, mainly due to the fact that this housing stock tends to be newer.

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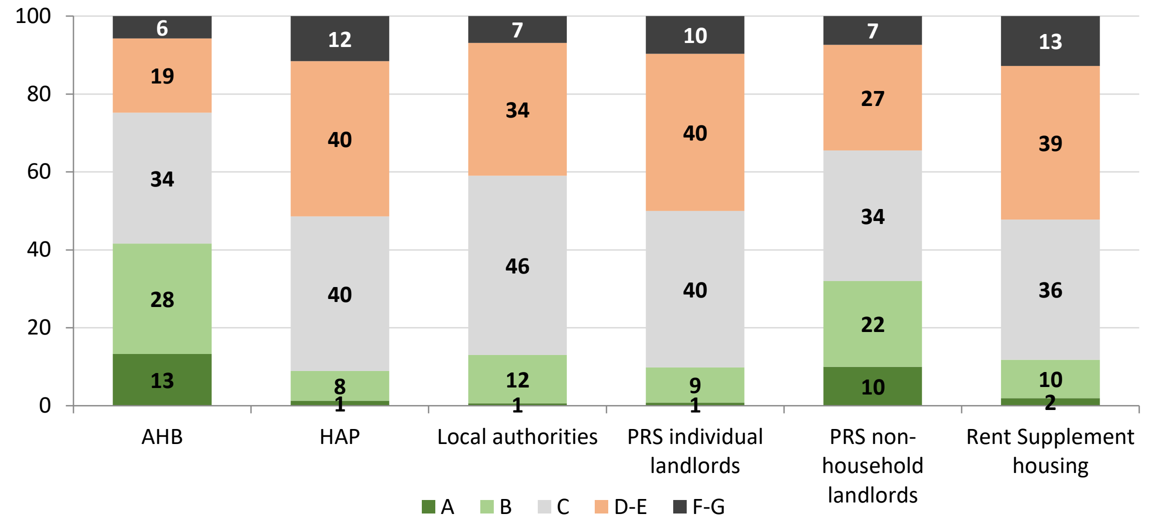
[3] Note both HAP and Rent Supplement recipients live in PRS housing.

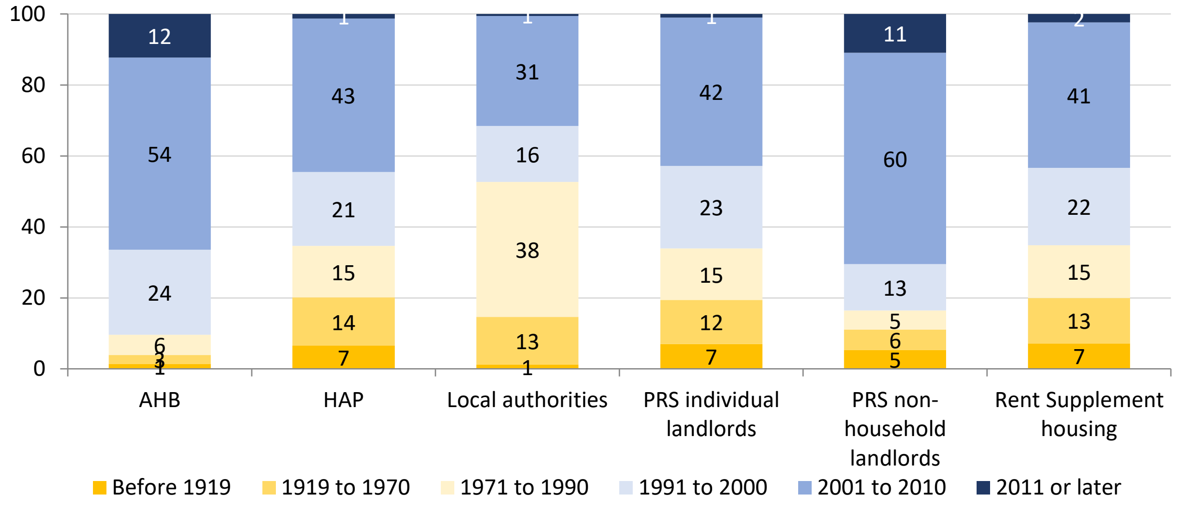
FIGURE 2.2 BER STRUCTURES FOR DIFFERENT GROUPS OF RENTAL SECTOR (% OF TOTAL)



Source: CSO data for 2020.
Notes: The RTB data only relate to new tenancies and Part 4 renewals, as the RTB did not collect annual registrations for the period in which the CSO undertook this analysis. PRS=Private rental sector. Note both HAP and Rent Supplement recipients live in private rental sector housing. The category of 'individual landlord' used here refers to those landlords who registered with the RTB using a PPS number, while the non-household landlords used a company registration office number.

This can be seen more clearly in Figure 2.3, which presents the age of properties owned by the same groupings of landlords. The majority of properties owned by the AHB sector as well as the non-household PRS sector were built post 2000, whereas this share is much lower for individual PRS providers as well as the local authority housing stock.

FIGURE 2.3 PROPERTY AGE BY LANDLORD TYPE (% OF TOTAL)



Source: CSO data for 2020.
Notes: The RTB data only relate to new tenancies and Part 4 renewals, as the RTB did not collect annual registrations for the period in which the CSO undertook this analysis. PRS=Private rental sector. Note both HAP and Rent Supplement recipients live in PRS housing.

These data indicate a considerable investment challenge for the sector, and in particular for individual landlords, if energy efficiency commitments are going to be met by the sector.

2.2 INTERNATIONAL LITERATURE

The issue of investment in energy efficiency technologies has come to the fore in recent years in line with aims to transition to low carbon economies internationally. Existing research indicates a general ‘energy-efficiency gap’, whereby the economic level of investment suggested by cost minimising (or energy saving) levels is well below that which is actually undertaken by households and firms. Allcott and Greenstone (2012) provide a detailed discussion of this issue and note that the ‘win–win’ argument for investment in energy-saving technology is that it can save fossil fuels (thus reducing all the harmful externalities that come from their usage) as well as help bridge an inefficient level of market investment by participants.

These two concepts intertwine two sets of market failure, which are important to separate out when trying to understand the underinvestment in energy efficiency. The first is the issue of negative externalities of the production of fossil fuels; the second concerns our understanding of the barriers to investment and the extent to which information asymmetries or other frictions such as credit market imperfections are driving investment choices. Allcott and Greenstone (2012) note the policy response varies depending on the two market failures; Pigouvian taxes or cap and trade programmes can be used for externalities, whereas other instruments to subsidise or mandate energy efficiency can be used to address the underinvestment.

In the context of this particular research, our focus is on the market failures relating to underinvestment in the residential real estate market. The types of market failures that can occur in this case are noted by Allcott and Greenstone (2012): information imperfections (a lack of information on what the optimal level of investment is for an individual household); inattention (missing key elements of the choice decision during the purchase decision); credit market access; and moral hazard. Given these factors, Allcott and Greenstone (2012) note that there is likely a very differentiated heterogeneity in investment inefficiencies across the population, thus policy targeting is required to deal with the differentiated challenges. However, challenges have been found in designing and implementing these policies internationally, such as attempting to use targeted instruments that do not have the desired impact (for example, Murphy et al., (2012) document these issues for the Netherlands by noting that the policies do not take into consideration the complexity involved with regard to existing dwellings).

These investment inefficiencies are all the more acute in the rental side of the housing sector due to the ‘split incentive’ problem. This issue relates to the situation whereby landlords are the investors, but the tenants are the ones who reap the reward through lower energy bills or other energy-saving benefits. This split incentive makes all the above market failures more acute and challenging to overcome. Castellazzi et al. (2017) note four specific types of split incentives:

- *efficiency-related* split incentives (the tenant pays the electricity bills but cannot choose the technology to improve the efficiency);
- *usage-related* split incentives (when occupants are not responsible for paying their utility bills and therefore have little or no interest to conserve energy);
- *multi-tenant, multi-owner* split incentives (this occurs where consensus is required for energy efficiency upgrades amongst a heterogeneous group of tenants/owners); and
- *temporal* split incentives (where the energy efficiency investment will not pay off before the property gets transferred across ownership).

Some research has found that energy performance certificates can mitigate some of these issues. Dwellings with higher levels of energy efficiency have a higher sales value, as well as a higher rental value (Fuerst et al., 2020). However, Cornago and Dressler (2020) document that landlords do not always disclose the energy certificates to tenants even if the certificate exist, and that many prospective tenants do not properly account for energy costs when deciding on which property to rent.

Ástmarsson et al. (2013) note that this misalignment of interests is one of the greatest barriers hindering the investment in sustainability from an energy efficiency perspective in residential buildings in Europe. A voluminous literature explores this issue internationally. A recent systematic review of the literature by Lang et al. (2021) notes the poorer energy efficiency of rented homes to owner-occupied properties in many countries across Europe, North America and Australasia. They note that small-scale landlords are the key decision makers and very little is known about their decisions. Looking across 16 papers, they find that 47 factors have been noted as determining their behaviour, including financial factors, values, beliefs, property-market factors and other aspects of their relationships with tenants.

Nie et al. (2020) explore the adoption of energy-saving measures between homeowners and renters in a survey of 1,248 households across three countries (Germany, Netherlands and Belgium). They find clear evidence of split incentive problems in relation to both energy efficient technology adoption and energy-saving behaviours. They find that homeowners are 16 per cent more likely than renters to adopt these technologies, though with a lower difference regarding behavioural measures.

Some of the reasons for non-investment in energy efficiency by landlords are noted in a paper on the UK market by Hope and Booth (2014). They study the reasons for landlords choosing not to invest in energy efficiency technologies, finding that the majority (67 per cent) indicate 'high-upfront costs'; other notable reported factors include 'tenants are happy with the energy efficiency' and 'no personal benefit to making improvements' (40 per cent). Access to finance or lack of information were not noted as barriers in their research. These findings are also echoed in research by Ambrose (2015) who undertook a research interview with 30 landlords in northern England and identified these relevant issues: split incentives, time costs, burden and information on the options.

Further research by Miu and Hawkins (2020) surveys the retrofit behaviour of private landlords in the UK and assesses their engagement across 18 different energy efficiency measures. They group landlords into seven behavioural typologies or landlord retrofitters, and suggest a segmentation of the landlord population into different target groups for heterogeneous policy interventions. They note that tailoring policy can better deal with a number of issues including policy support take-up, increasing the likelihood of retrofit and accelerating the energy-efficiency transition.

Further evidence is also available to support policy instrument combinations to deal with this issue. In research on the Danish rental sector, Ástmarsson et al. (2013) find that these principal agent problems can only be overcome with a package solution that includes legislative changes, financial incentives and better dissemination of information.

In an attempt to provide a cross-country solution to the informational asymmetries component of the energy efficiency gap in rental housing, a major EU-funded research project RentCal produced a tool that can help break down information barriers (Zeitler, 2018).

Other studies look at different aspects of the regulations used to incentivise investments in energy efficient technologies. For Germany, Weber and Wolff (2018) find that landlords pass on investment costs to tenants as is allowable under rent control legislation, and these costs are higher than the energy efficiency savings. This is an important finding in an Irish context as such an exemption is allowable in Rent Pressure Zone areas. Charlier (2015), in a study on French data, shows tenants are lower income and unable to invest due to insufficient funds. Maruejols and Young (2011) use Canadian data and find that tenants' behaviour depends on whether they face the cost of energy usage amounts.

2.3 SUMMARY OF RELEVANT IRISH RESEARCH

A number of research studies have been conducted on Irish residential energy efficiency in the rental sector. Petrov and Ryan (2021) test for the persistence of the landlord–tenant energy efficiency problem in Ireland. They find that the issue is present but to a varying degree across areas, indicating differential issues.

Pillai et al. (2021) consider issues such as low-income renters and the financial barriers to investment. This research finds that key behavioural and informational barriers prevent low-income households from fully comprehending the purpose or benefits of proposed energy efficient retrofits. It also finds that the investment targeting of grants matters: higher grant expenditure on dwellings with a poor pre-works energy efficiency rating and on retrofits, such as attic insulation and heating system upgrades, may have the highest energy efficiency improvements per unit of expenditure.

Coyne (2023) provides an overview of retrofitting activity across the total residential housing stock in Ireland and the various policy instruments that have been deployed. Comparison with other European countries shows that the energy efficiency of Irish housing stock is similar to that of peer countries.

Carroll et al. (2016), considering the issue of asymmetric information in explaining low energy efficiency in rental properties in Ireland, note that energy ratings, while a solution to the information problem, will only lead to higher efficiency levels if renters’ willingness to pay exceeds landlords’ investment costs. Using a survey experiment, they show that that there is a strong disutility on the side of tenants for choosing the least efficient properties and that they will be willing to pay more for some efficiency improvements at the lower end of the efficiency scale. This therefore should be factored into the policy response in terms of ensuring that landlords have a reasonable pricing decision when changing the energy rating. However, their findings also note that this information was needed in advance by all participants.

Collins and Curtis (2018a) use administrative data on the Sustainable Energy Authority of Ireland (SEAI) grant scheme to explore the upfront costs to landlords of the retrofits and the payback period. Tenants in Ireland are found to be willing to pay an extra €38 to increase the BER by one point. They find that given this willingness to pay, the investment recoup period differed by type of retrofit; attic and cavity wall insulation had a short payback period, with solar heating and external wall insulation having a longer period of payback. Other research by Collins and Curtis (2018b) explores willingness to pay and ‘free riding’ regarding relevant policy initiatives. It should be kept in mind that aspects of the Irish rental market have changed since many of these studies were carried out.

From a policy perspective, a Society of St. Vincent De Paul (2015) report identified a need for legislation to ensure minimum efficiency more generally, as renters were found to be more vulnerable than homeowners. Similarly, a joint report by the Society of St. Vincent De Paul and Threshold (2022) highlights the risk to tenants of energy-efficiency renovation possibly being preceded by tenant evictions, or renovation being used to justify disproportionate increase in rents. This situation is further complicated in an Irish context where issues regarding the reporting of poor-quality dwellings may arise due to concerns on the tenants' side (Byrne and McArdle, 2022).

This research study represents first widescale attempt to quantify, with granular microdata, the scale of the retrofit challenge for the Irish PRS. It also contributes to the existing research literature by considering the challenges, from a financial capacity perspective, faced by household landlords when it comes to investing in improving the energy efficiency of their rented properties.

CHAPTER 3

Profiling the energy efficiency of the private rental sector

3.1 INTRODUCTION

An assessment of the energy efficiency investment challenge in Ireland first requires an adequate understanding of the current profile of the private rental housing stock. The aim of this section is to provide such a profile, with an emphasis on the current distribution of energy efficiency as measured by building energy ratings (BER). We will draw on two datasets for the purpose of this analysis: the Residential Tenancies Board's (RTB) database of existing and new tenancy registrations; and the Sustainable Energy Authority of Ireland's (SEAI) anonymised research data on BER assessments since 2009. Both datasets are summarised in detail below, with some cross-comparisons provided. In the final section of this chapter, the two datasets are augmented with information from the 2022 Census to estimate the total number of properties at each BER rating in the Irish private rental market.

3.2 RTB REGISTRATIONS DATA

The primary source of information used in this research to profile the energy efficiency of the private rental sector (PRS) is taken from the Residential Tenancies Board (RTB) registry of both new and existing ongoing tenancies. Since April 2022, all active tenancies in Ireland are required by law to be registered with the RTB on an annual basis, within one month of the anniversary of the original tenancy commencement date. This is in addition to the registration of new tenancies, which has been in place since 2007. These data provide the most comprehensive and detailed overview of properties in the PRS (outside of the Census of Population conducted every five years). Note these data exclude both student-specific accommodation and properties provided by the approved housing bodies (AHBs), which are kept on separate registers. The data do include any private rental properties where tenants are in receipt of state housing supports such as the Housing Assistance Payment (HAP), the Rental Accommodation Scheme (RAS) and Rent Supplement.

For this research, we use an extract from the dataset that contains information on all new and existing tenancies registered over the period April 2022 to April 2023 – the first 12 months for which annual registrations data have been collected. A summary of the observations on the number of properties available for the analytical sample are presented in Table 3.1.

TABLE 3.1 RTB-REGISTERED PROPERTIES ACROSS REGISTRATION TYPE

Registration type	Frequency	%	Cumulative
Annual registrations and renewals	135,454	65%	65%
New tenancies	73,581	35%	100%
Total	209,035	100%	

Source: RTB tenancy registrations data, April 2022–April 2023.

A total of 130,524 properties are taken from the annual registrations and 'further Part 4 renewals' category, while 73,581 are new tenancies from that period. Our analysis is a sample from the overall database that follows the cleaning steps outlined in Slaymaker and Shiel (2023).[4]

The RTB dataset contains a range of fields that are particularly useful for the purposes of this research. The dataset contains precise information on the geographic location and address of each property. It includes the eircode of each property, as well as a number of different fields on: the type of property (detached house, semi-detached house, terraced house, apartment); the number of bedrooms; the number of tenants; and some other characteristics of the tenancy such as the length of the original agreed tenure.[5] The dataset also contains information on the floor area of the property in metres squared, which is an instructive variable in terms of both the property size and the likely required investment.

Figure 3.1 presents summary statistics for the sample across the property types included in the dataset. Apartments make up the largest category of properties in the sample (including studio apartments), at 52 per cent of the total (108,851 properties). All the other registered properties are houses: just under 10 per cent are detached houses (20,199); around 23 per cent semi-detached houses (47,936); and the remaining 15 per cent are terraced houses (32,048).

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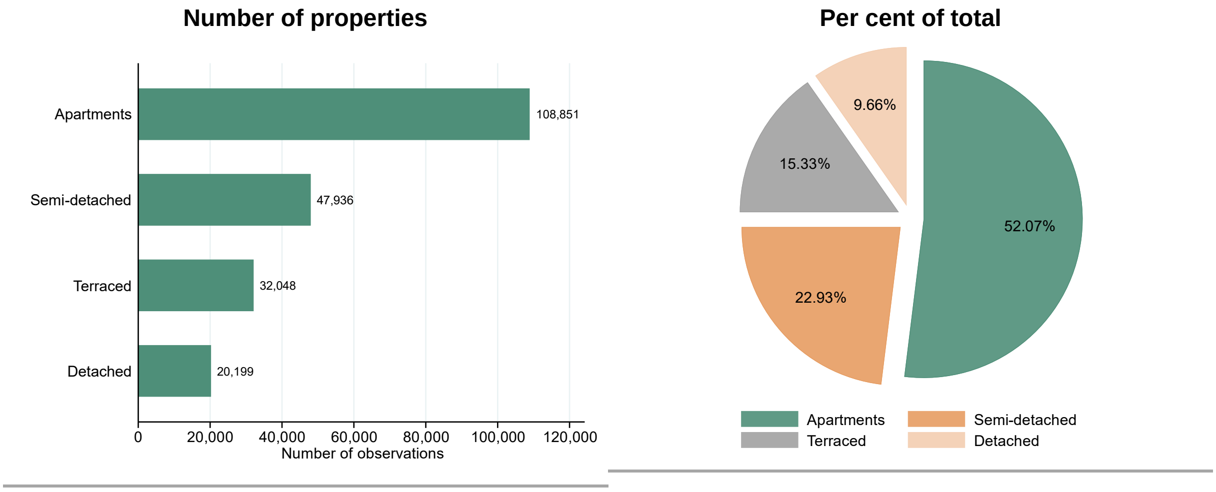
[4] This number is lower than the number of PRS rented dwellings captured in the Census. A recent analysis by the CSO and the RTB showed that approximately two-thirds of the gap is due to informal rental arrangements and the remaining one-third likely comprises formal agreements not registered with the RTB (https://www.cso.ie/en/releasesandpublications/rp/rp-rfpl/rentedfromprivatelandlords2022/). The cleaning process in Slaymaker and Shiel (2023) is outlined as follows: include tenancies that are identified as either 'new' or 'annual registration' by a registration status identifier. This verification process is boosted by extensive checks utilising information on tenant names, addresses and eircodes to establish property/tenant histories. These were then used to verify a tenancy's status as being either a new one or an annual registration.

[5] It must be noted that we do not have access to a property-specific MPRN number or a BER number that would allow a matching to other datasets, such as the BER information.

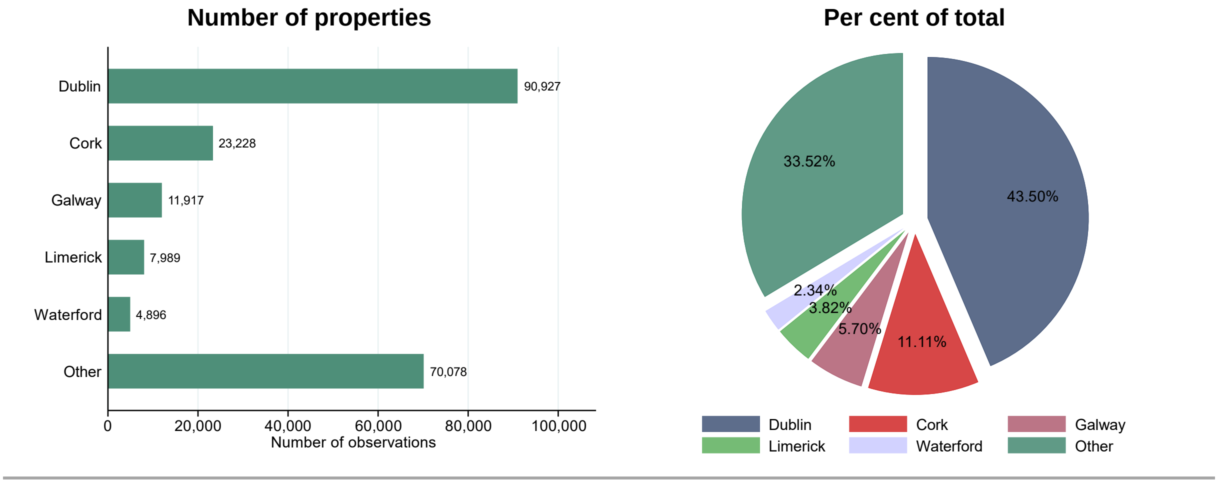
FIGURE 3.1 RTB-REGISTERED PROPERTIES ACROSS DWELLING TYPE



Source: RTB Registrations data.

Figure 3.2 presents summary statistics for the RTB sample across broad geographic areas. As the rental sector in Ireland is predominantly urban in nature, it is unsurprising to see counties Dublin and Cork accounting for the largest single shares of the market. Around 43.5 per cent of the sample is in Co. Dublin (90,927 properties), just over 11 per cent is in Cork (23,228), a further 5.7 per cent of properties (11,917) is in Galway with 3.8 per cent and 2.3 per cent in Limerick and Waterford counties respectively. Remaining properties, across the country, account for just under 34 per cent of the total (70,078 properties).

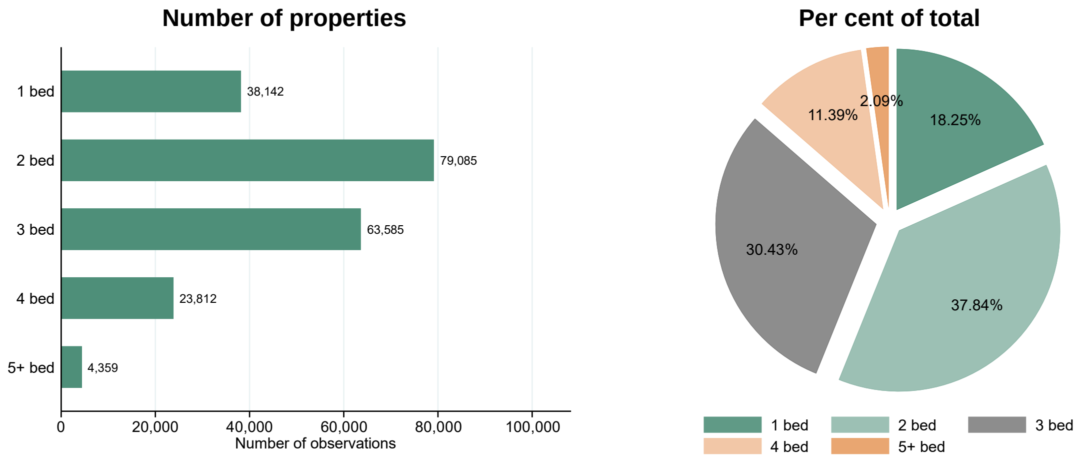
FIGURE 3.2 RTB-REGISTERED PROPERTIES BY COUNTY



Source: RTB Registrations data.

Figure 3.3 presents summary statistics on the number of bedrooms per property across this sample. The number of bedrooms is capped at five by truncating the distribution. The number of bedrooms per property is a good guide to the overall size. It was found that 18 per cent of properties were one-bed, 38 per cent were two-bed, 30 per cent were three-bed while a further 11.4 per cent were four-bed. Just over 2 per cent of properties have five or more bedrooms.

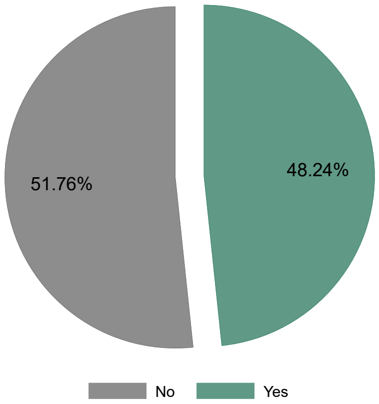
FIGURE 3. 3 RTB-REGISTERED PROPERTIES BY NUMBER OF BEDROOMS



Source: RTB Registrations data.

Of particular importance for this research is a measure of the underlying energy efficiency of rented properties. The RTB data include a self-reported BER, which can be provided by the landlord when the tenancy is registered. As it is legally mandated to have a BER for the property, many landlords would have this information; however, despite this only 48 per cent of the observations in our sample contain a value for this self-reported BER (as seen in Figure 3.4). This is a notably low figure and creates a challenge in terms of potential sample selection biases as to which properties are potentially missing this information. While this issue is discussed in detail below, the potential impacts are that the missing data are non-random, which would bias the observed distribution. For example, if the missing data were systematically of poorer BER data, this would overweight the sample towards better energy efficiency properties.

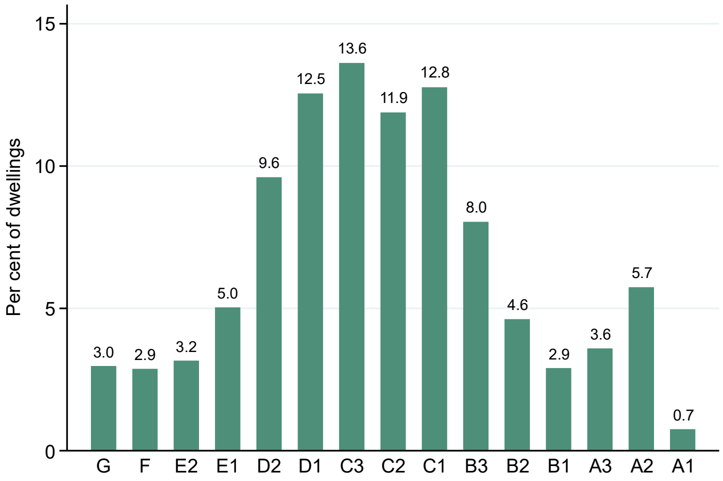
FIGURE 3. 4 RTB-REGISTERED PROPERTIES WITH SELF-REPORTED BER



Source: RTB Registrations data.

Figure 3.5 presents the distribution of BER ratings across those properties listed as having a self-reported BER. It shows that very few properties in the Irish PRS have an A rating; just over 10 per cent of the properties are listed as having an A rating, with fewer than 1 per cent having an A1 rating. In terms of B-rated PRS properties, 8 per cent have a B3 rating, 4.6 per cent have a B2 rating and 2.9 per cent have a B1 rating, totalling 15.5 per cent of properties with an overall B rating. As the energy efficiency requirements are likely to encourage dwellings to be at least B rated, these data highlight the considerable challenge facing the sector in terms of investing sufficiently to reach this particular level. Indeed, according to these data, just under three in every four properties in the rental sector do not meet a B rating. A majority of properties have either a C or D rating; 13 per cent have a C1 rating, 12 per cent have a C2 rating, and 14 per cent have a C3 rating, totalling 38 per cent. Regarding D-rated properties, 12.6 per cent have a D1 rating, while 9.6 per cent have a D2 rating. Focusing in on the lowest rated properties, which are likely to have the greatest challenge in terms of the energy efficiency investment requirements, 8.2 per cent have an E rating, 2.9 per cent have an F rating and 3 per cent have a G rating – the lowest possible BER.[6]

FIGURE 3. 5 DISTRIBUTION OF SELF-REPORTED BER OF RTB-REGISTERED PROPERTIES



Source: RTB Registrations data.
Note: Excluding properties without self-reported BER. Data without adjustments.

In order to provide more granular detail on which properties have different BER ratings and where those properties are located, Figure 3.6 presents high-level BER distributions across property types and across counties. Focusing on the geographic split, data are presented for Dublin, Cork, Galway, Limerick, Waterford and 'Other counties combined'. It is clear that more of the A-rated properties are located in Dublin; this likely reflects the fact that in recent years Dublin has accounted for a greater proportion of new housing supply in the rental sector,

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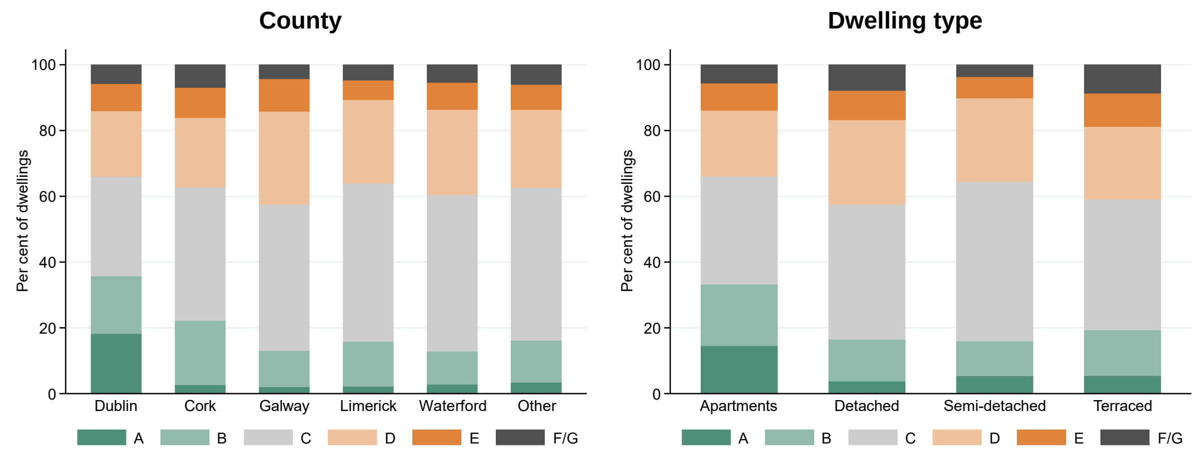
[6] For any further information on the BER scale etc, please see: https://www.seai.ie/publications/Your-Guide-to-Building-Energy-Rating.pdf.

many of which are new, build-to-rent properties (Daly, 2023). These newly constructed properties will have been built under the current higher energy rating standards. Cork has the second highest share of B- or higher rated properties after Dublin. Galway and Limerick are the areas with the greatest proportion of D or lower ratings in the data. Figure 3.6 also presents the high level ratings by property type: apartment, detached, semi-detached and terraced. Apartments represent the most energy efficient group, with the highest share of A- or B-rated properties. Houses, of any type, had fewer than 20 per cent of the stock at B or higher rating but approximately 60 per cent across these groups had a C or higher rating.

FIGURE 3.6 BER DISTRIBUTION BY COUNTY AND DWELLING TYPE



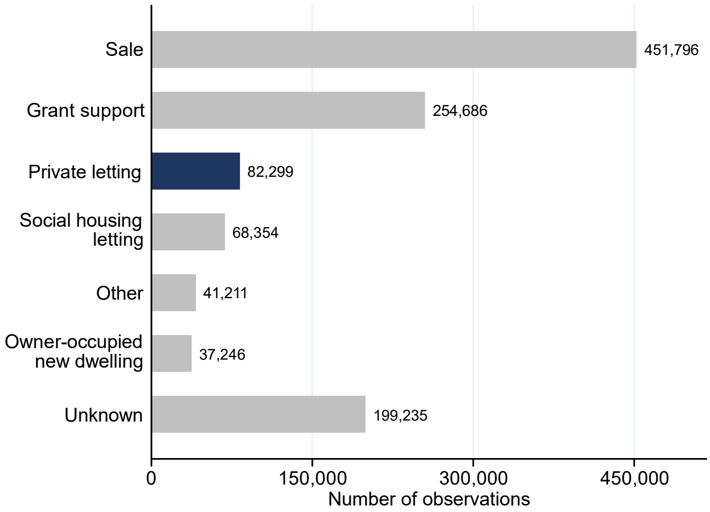
Source: RTB Registrations data.

3.3 SEAI BER DATABASE

The RTB dataset described above is the largest sample available on the rental sector at the micro level, with energy efficiency indicators. However, due to the self-reported nature of the information and the large proportion of non-reported ratings, there may be some biases in the information, whereby landlords may misreport the true rating or where the data may be missing systematically.

To attempt to provide a robustness check against this occurrence, we draw on a second data source: the SEAI BER Research Tool micro database, which is made available by the SEAI for research purposes. While these data do not contain a specific indicator for whether a property is currently being rented, or provide a stock of rental market properties, they do have some useful information that we can draw on. These data allow us to identify those properties for which the purpose of the BER certificate application was for ‘private letting’. We assume these properties are active and in the rental sector. It also pools all data across the years of the BER (2009–2023 in our sample).

FIGURE 3. 7 NUMBER OF ASSESSMENTS BY ASSESSMENT PURPOSE



Source: SEAI BER Research data.

The database provided by SEAI contains extensive information that was captured as part of the BER process. The research tool provides data on the BER scheme for approximately 1.1mn observations. It includes all information collected as part of the BER process: energy performance of the dwelling;[7] heating; ventilation; lighting; and property characteristics, etc. The data are anonymised; for example, the meter point reference number (MPRN), name(s) and address have all been removed from each entry. Critically for the purposes of our research, a number of relevant fields (the BER notwithstanding) are included. These include: year of construction, type of property, purpose of BER certificate (sale, rent etc.), and year of application.

As noted above, using these data, we can identify a subset of 82,299 observations, from the overall database, that relate to rental properties only. These are the properties whose declared purpose was that the BER was obtained for private letting (i.e. the BER was applied for because the property was to become part of the PRS). The reasons property owners gave for seeking a BER certificate are presented in Figure 3.7. It is clear the vast majority of the BER ratings were obtained for other purposes (for example sale, grant support, owner occupation, etc). A number of points are worth noting. Properties that are currently in the rental sector could have obtained a BER certificate through a sale process, or from a grant application etc. Only using the group of properties that sought a BER rating for the specific purpose of renting the property in our sample means we exclude

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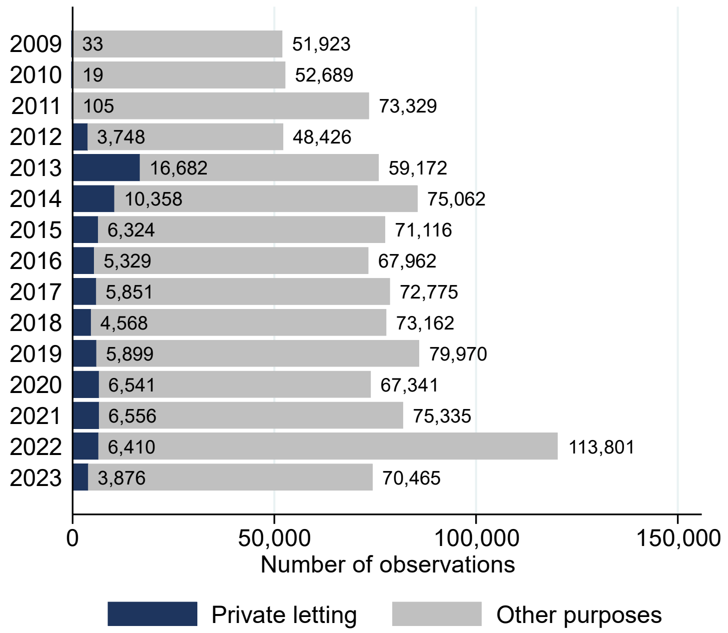
[7] The BER certificate provides a measured scale of A–G, which gives an energy performance score that is comparable across properties (with A being the highest energy efficiency). Each property is provided a score of energy use per unit floor area per year (kWh/m2/yr). For an example, please see: https://www.seai.ie/home-energy/building-energy-rating-ber/understand-a-ber-rating/Sample-BER-Cert.pdf.

these groups. However, this was unavoidable, as we are unable to identify rental sector properties from within the other categories.

There is a second important consideration. Properties could have been in the owner-occupied market and then transferred to the rental sector or from the rental sector to owner occupation. We therefore cannot determine whether or not these 82,299 properties are still in the rental sector at present. It must also be noted that a single property could have multiple BER assessments, in which case it would therefore appear multiple times in the data. Despite these limitations, we use these data as a robustness check on the RTB data, which do not suffer from these entry and exit challenges.

FIGURE 3.8 NUMBER OF ASSESSMENTS BY YEAR OF ASSESSMENT

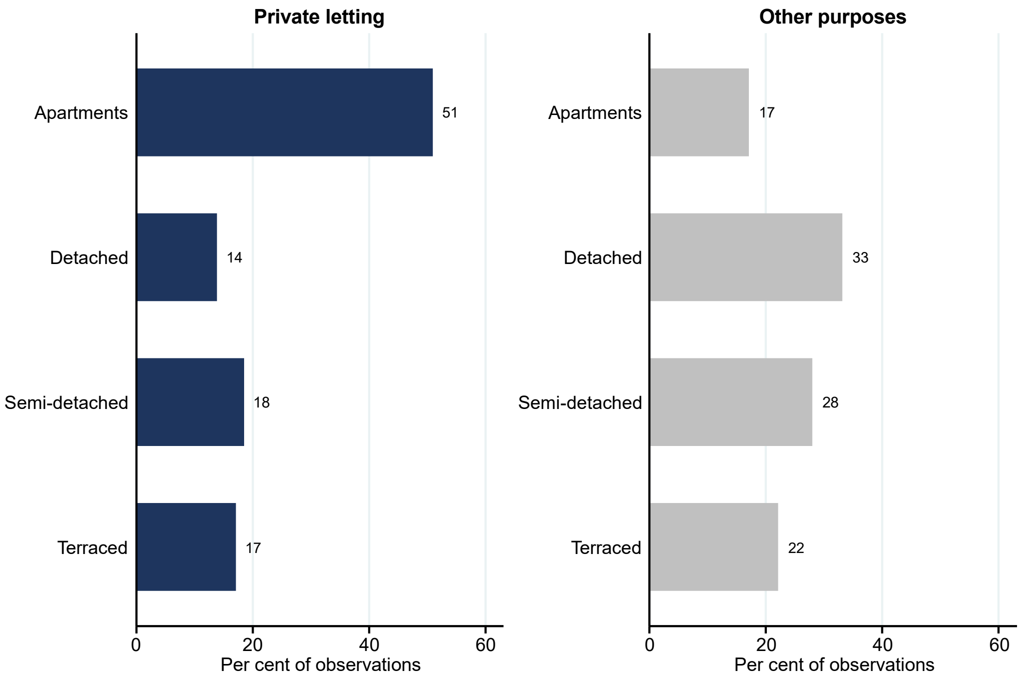


Source: SEAI BER Research data.

The year of completion for the BER certificates are presented in Figure 3.8. It shows that the privately let properties in the sample had their BER assessment completed at different points in time. The figure covers privately let properties and all other purposes combined. While overall a greater proportion of BER certificates have been obtained in more recent years, in the privately-let sample, more than one-third of assessments are from 2014 or earlier.

Figure 3.9 presents properties for private rental and other purposes across a number of housing stock categories: apartments, detached houses, semi-detached houses, terraced houses and other. The private lettings data are much more skewed towards apartments, with just over 50 per cent of the observations coming from this housing type. There are fewer detached and semi-detached houses in the rental sample compared to the ‘other purposes’ sample.

FIGURE 3. 9 NUMBER OF ASSESSMENTS BY DWELLING TYPE



Source: SEAI BER Research data.

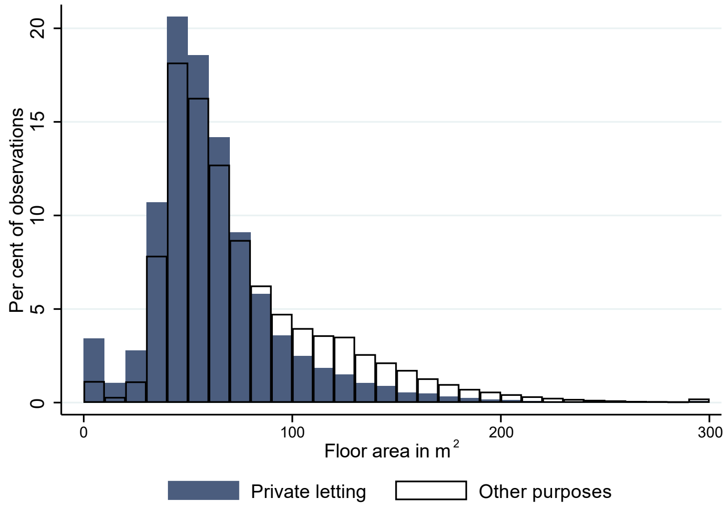
FIGURE 3.10 NUMBER OF ASSESSMENTS BY YEAR OF CONSTRUCTION

Source: SEAI BER Research data.

An interesting factor available from the SEAI data that is not available in the RTB data is property age. Older properties are likely to be of poor quality regarding energy efficiency, if they have not been upgraded. Therefore, this is an important variable in terms of providing insight into our understanding of the investment requirements for the sector. Figure 3.10 shows the age distribution of privately rented and other properties by BER status. Two interesting trends emerge: there are more very old properties (pre-1900) in the rental sector; and fewer privately-let properties were built during the 1960s, 1970s and 1980s. That period (1960s to

1980s) saw a major expansion in homeownership in Ireland; many of the new builds from that era are likely to have remained in that tenure category. By contrast, the 2000s saw a greater proportion of privately-let properties being built, as it was during that decade that buy-to-lets became a major part of the Irish housing market.

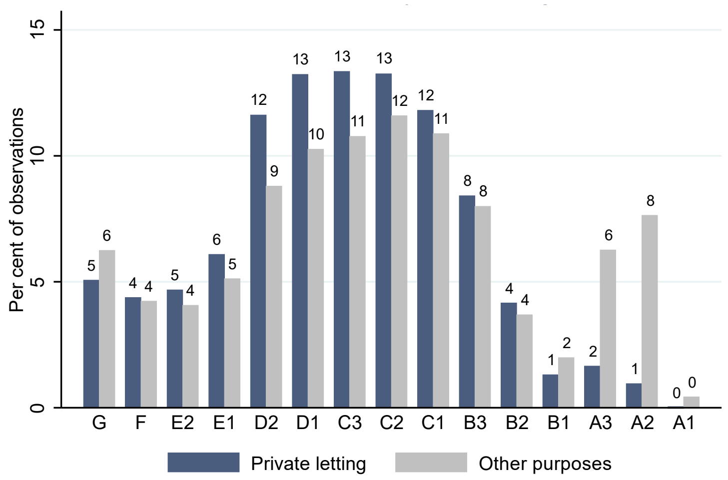
FIGURE 3.11 NUMBER OF ASSESSMENTS BY FLOOR AREA



Source: SEAI BER Research data.

Figure 3.11 shows the size distribution for private rental BER ratings and the rest of the dataset. The metric presented is the floor area in metres squared. Two overlaid histograms are presented, with the blue data representing the rental sector. These data indicate that the properties in the rental sector are typically smaller than their equivalents in the other categories.

FIGURE 3.12 BER RATINGS DISTRIBUTION OF ASSESSMENTS

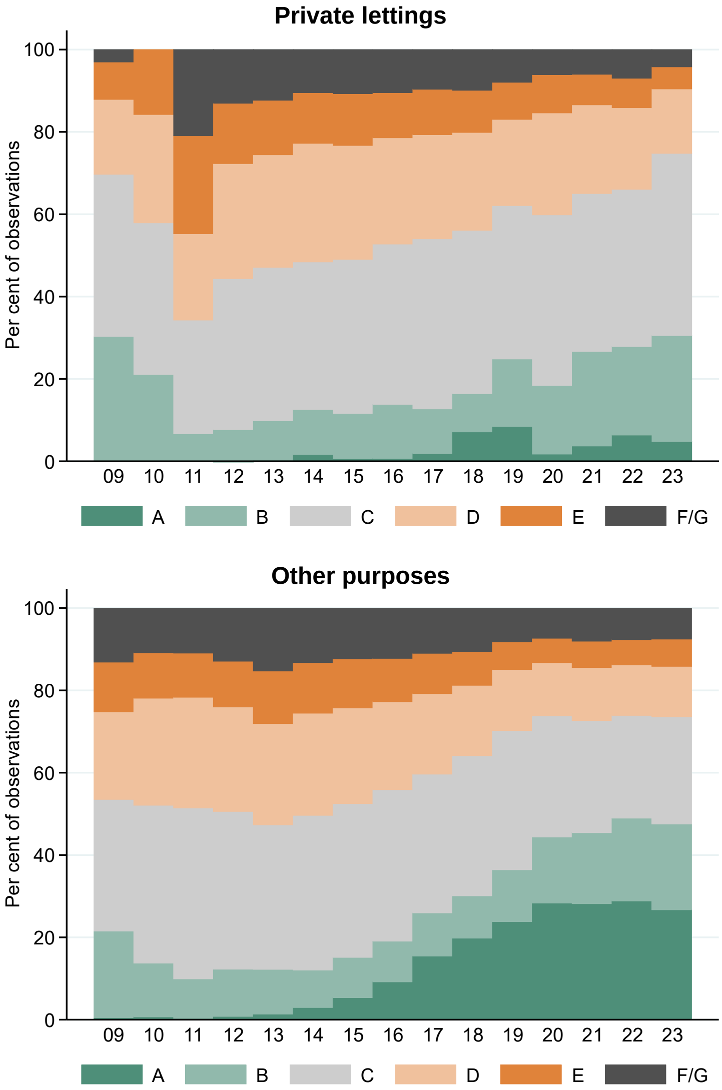


Source: SEAI BER research data.

Finally, and of critical importance, is the BER distribution associated with these data. This is presented in Figure 3.12. It shows there are disproportionately more C-, D- and E-rated properties in the rental sector data, with notably fewer A rated properties.

One possible reason for the overall lower energy efficiency in the SEAI data, compared to the RTB data, is that the SEAI sample includes historic data. Figure 3.13 shows the change in the distribution of BER ratings over the years of assessment. There is a notable increase in energy efficiency in both the rental sector and in the 'other purposes' groups. The figure also shows that the rental sector's energy efficiency is lagging behind that of buildings assessed for other purposes.

FIGURE 3.13 BER ASSESSMENTS DISTRIBUTION BY YEAR OF ASSESSMENT



Source: SEAI BER Research data.

3.4 CENSUS RECONCILIATION AND COMPARATIVE ANALYSIS

Having reviewed both the RTB and SEAI datasets, our next goal is to estimate the total number of dwellings in the PRS at each BER level. In doing so, we also make adjustments to the data to account for protected heritage buildings. These buildings are BER exempt and restrictions apply regarding the types of potential energy efficiency upgrades that could be carried out on them, which would likely impact the upgrade costs. These protected buildings are therefore outside of the scope of this report, which uses the current National Retrofit Plan, published as part of Climate Action Plan 2021, as its baseline context. The details of this analysis are presented in Appendix B.

3.4.1 Residential Tenancies Board data

As shown in Figure 3.4, 52 per cent of observations in our RTB dataset do not include a BER rating. One of the challenges here is the potential for bias in the self-reported BER distribution. For example, it is possible that some landlords with less energy-efficient properties may not report their BER rating, which would bias our sample distribution towards having a higher rating than is the case for the actual population of properties in the sector. Furthermore, there could be impacts of bias whereby those properties complying with RTB registration in the first place may be more likely to have a high BER and to report it. There are also likely to be other confounding effects that can impact the distribution of self-reported BER ratings, which are not listed here (such as economic or legal variables that impact the preference of the landlord for compliance with the registration process).

Two biases are therefore worth considering. The first is whether the data that includes self-reported BER ratings, in the RTB data, are systematically different from those which do not. The second is whether the RTB sample is representative of the overall population of rental properties. To explore the first issue, we present a number of tables that compare properties with a self-reported BER rating against those that do not have a self-reported BER. If any major systematic differences are found to exist between the two groups, this would support the possibility of bias in the BER reporting.

The first set of characteristics considered in our assessment are as follows: floor area; monthly rent; number of tenants; number of bedrooms; and property type. The data are presented in Table 3.2. The observations for ‘no BER’ have lower rent and are also smaller in terms of floor area, number of tenants and number of bedrooms. There are proportionally more detached houses without a reported BER than with one (10.3 per cent to 9 per cent). There is a higher share of apartments with a reported BER, with apartments making up 51.6 per cent of the sample with a BER rating, compared to 50.5 per cent of the without one. The proportions of semi-detached and terrace houses are similar in both samples, with no statistically significant difference.

TABLE 3.2 CHARACTERISTICS OF PROPERTIES WITH BER COMPARED TO WITHOUT BER

Variable	No BER	With BER	Difference
Floor area	88.92	89.6	-0.68***
Monthly rent	1302.2	1489.8	-187.7***
Number of tenants	1.828	1.886	-0.058***
Number of bedrooms	2.416	2.475	-0.059***
Apartments	0.505	0.516	-0.011***
Detached	0.103	0.090	0.014***
Semi-detached	0.235	0.238	-0.003
Terraced	0.157	0.157	0.000

Source: RTB Registrations microdata.
Notes: *** significant at 1 per cent level using t-test. Floor area trimmed 5, 95 per cent for outliers.

We now consider the differences between properties with reported BER status versus those without this on a geographic basis. These are presented in Table 3.3. In Dublin, there is a notably higher proportion of properties with a reported BER status (Dublin makes up 46 per cent of the total ‘with BER’ sample) than without (Dublin properties comprise 40 per cent of the ‘without BER’ sample) compared to the breakdown in other areas. In Cork, there is a higher proportion of properties without a reported BER status (Cork accounts for 12.3 per cent of the total ‘without BER’ sample) than properties with one (Cork makes up 9.9 per cent of the total ‘with BER’ sample). There are also differences in the other areas presented, with Galway making up a comparatively higher share of the ‘with BER’ sample and Limerick, Waterford and the rest of the country accounting for a comparatively higher share of the ‘without BER’ sample.

TABLE 3.3 CHARACTERISTICS OF PROPERTIES WITH BER COMPARED TO WITHOUT BER

County	Without BER	With BER	Difference
Co. Dublin	0.406	0.461	-0.055***
Co. Cork	0.123	0.099	0.024***
Co. Galway	0.054	0.061	-0.008***
Co. Limerick	0.045	0.031	0.014***
Co. Waterford	0.026	0.020	0.006***
Rest of the country	0.346	0.327	0.019***

Source: RTB Registrations microdata.
Notes: *** significant at 1 per cent level using t-test/ Floor area trimmed 5, 95 per cent for outliers.

Tables 3.2 and 3.3 clearly show that differences exist between the properties which have and do not have a self-reported BER rating, based on observable characteristics. For this reason, we propose the following methodology to deal with this issue, based on developing a set of probability weights. We first define a dummy variable which takes the value of 1 for those properties which have a self-reported BER, and 0 otherwise:

$$HasBER = \begin{cases} 1 & \text{if BER reported} \\ 0 & \text{otherwise} \end{cases}$$

We then run a regression model of the probability of not having a BER rating as a function of observable characteristics. In our list of observable characteristics, we include the following: the floor area and rent amount as levels and their squared terms, property type dummies, and indicator variables for the county:

$$\Pr(\text{HasBER} = 0) = f(\text{rent}\,, \text{rent}^2, \text{floor}\,, \text{floor}^2\,, \text{dwelling type}\,, \text{urban}\,, \text{county})$$

This probability is estimated as a logit model, with the results shown in the appendix.[8] Following the estimation, we predict for each property the probability of having a self-reported BER $\hat{p}_i$ based on the characteristics in the regression and the estimated coefficients. We then use these predicted probabilities to re-weight the sample.

The resulting distribution is shown in the middle columns in Figure 3.15. In the re-weighted sample, the proportion of A* and B* ratings is lower than before the adjustment, while increases are seen for C* and D* ratings. The proportion of properties rated E and below remains similar.

A final sample adjustment that we make is to further re-weight the RTB sample by county and dwelling type, such that the number of observations in the RTB sample corresponds to the Census 2022 data by county and dwelling type (of which there were 330,632 dwellings in the PRS). We attempt to match the data as closely as possible in terms of dwelling types but common groupings are required. The mapping that corresponds the RTB data and the Census data is presented in Table A.1.

Furthermore, we make a number of adjustments to account for the BER-exempt status of the protected heritage buildings in the RTB data. First, we develop a process that attempts to identify listed buildings in the data and to remove these from our analysis of energy upgrade requirements. This process is outlined in Appendix B, and leads to approximately 5 per cent of the RTB observations being identified as of a protected nature, thus reducing the RTB sample from 209,035 to 196,305 dwellings. Given the special requirements of these buildings in terms of

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[8] Due to the presence of outliers, monthly rent and floor area have been trimmed for the bottom and top percentiles. Additionally, some observations had missing information in these two variables. For those observations, the values were imputed. A logit model is an estimation procedure that uses a distributional form catering for binary outcome variables. It draws on the logistic distribution.

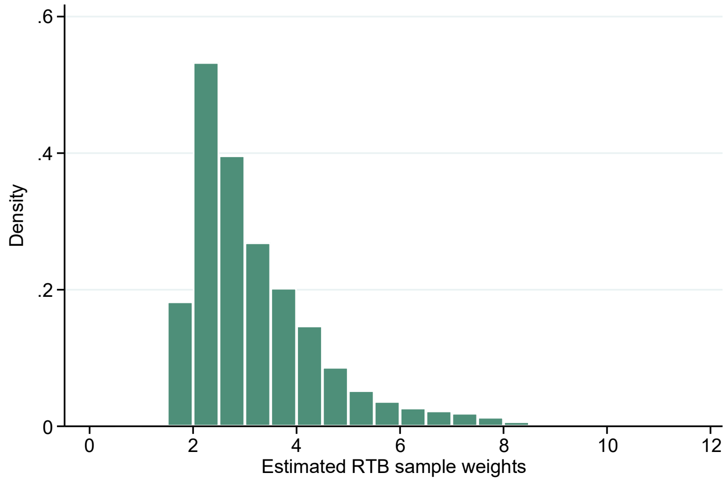
their built structures, we do not attempt to apply an energy efficiency upgrade to them, and they are removed from our sample.

To account for the heritage buildings, we also adjust down the overall Census data by this proportion and then use the adjusted data to weight the RTB sample. In total, the Census data used amount to an estimated 312,537 non-heritage dwellings in the PRS, while the non-heritage RTB sample has 97,261 observations with the non-missing BER. The final weights w_i for a dwelling i in county c of dwelling types d are:

$$w_i = \frac{\widehat{p_\iota}}{\bar{p}} \times \frac{N(\text{Census}_{cd})}{N(RTB \text{ NonMissing}_{cd})}$$

The first term adjusts for the non-reported BER ratings using the logit-estimated probabilities $(\widehat{p_\iota})$, normalised by the average probability in the reported BER sample. The second term adjusts the overall weights to make the RTB sample adjust to the number of dwellings recorded in the Census for every county and dwelling-type cell. On average, one observation in the final RTB sample with a reported BER status will represent three dwellings in the rental market. The distribution of weights is presented in Figure 3.14. The Census weights are higher for detached homes and for non-urban counties (e.g. Monaghan, Cavan, Clare, Leitrim and Laois), where the weights are between 5 and 7.5. Meanwhile for apartments in Dublin the Census weights are 2.4.

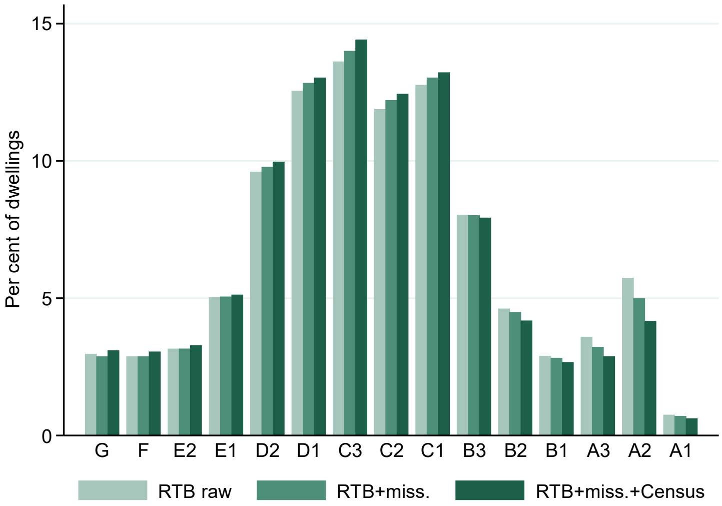
FIGURE 3.14 DISTRIBUTION OF SAMPLE WEIGHTS, W_T



Source: Calculations using RTB tenancy registrations data and 2022 Census.

The readjusted BER distribution, with the raw data and two-step weighting process, is presented in Figure 3.15. It can clearly be seen that these adjustments emphasise the lower BER categories to a greater extent as these were under-represented in the initial RTB sample. For example, as shown earlier in Table 3.2, properties with low rent are more likely to not have a reported BER status. With the logit-probability adjustment, the observations with rent below €1k and that have a BER get a higher sample weight (approximately 1.2) to compensate for non-reported observations. At the same time, high-rent observations (rent above €2k), receive a weight of 0.8. This shifts the distribution towards lower BER ratings. Adjustment with the Census weights further shifts the distribution down, because houses and rural dwellings are under-represented in the RTB sample compared to the numbers from the Census. As shown in Figure 3.6, these groups have on average lower energy efficiency.

FIGURE 3.15 DISTRIBUTION OF BER RATINGS IN RTB DATA BEFORE AND AFTER ADJUSTMENTS



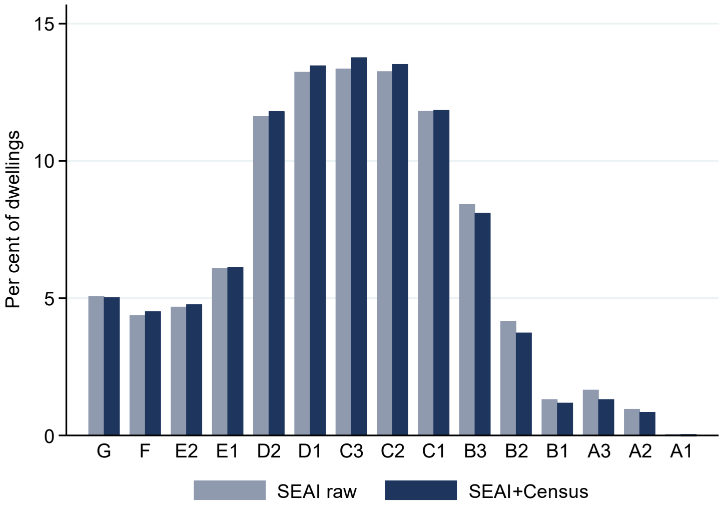
Source: Calculations using RTB tenancy registrations data and 2022 Census.

3.4.2 Sustainable Energy Authority of Ireland data

For the SEAI sample, we use a similar process to that applied to the RTB data to re-adjust the data so that it lines up with the Census. A number of potential sample selection biases arise with the SEAI data; for example, given it is for grant applications there may be confounding factors that determine the type of properties the applications concern (such as the existing level of the BER), which may impact the BER distribution in the data. This bias may distort the distribution in the data relative to the underlying property distribution. Additionally, the indicator variables do not allow us to identify current rental properties so the distribution may be biased in a temporal sense.

To attempt to deal with this, we apply a set of weights that provide an uplift of the SEAI data, such that the total number of properties, across counties and dwelling types, matches the Census data. This allows us to provide an adjusted distribution of the SEAI data BER distribution in Figure 3.16.

FIGURE 3.16 DISTRIBUTION OF BER RATINGS IN SEAI DATA BEFORE AND AFTER ADJUSTMENTS

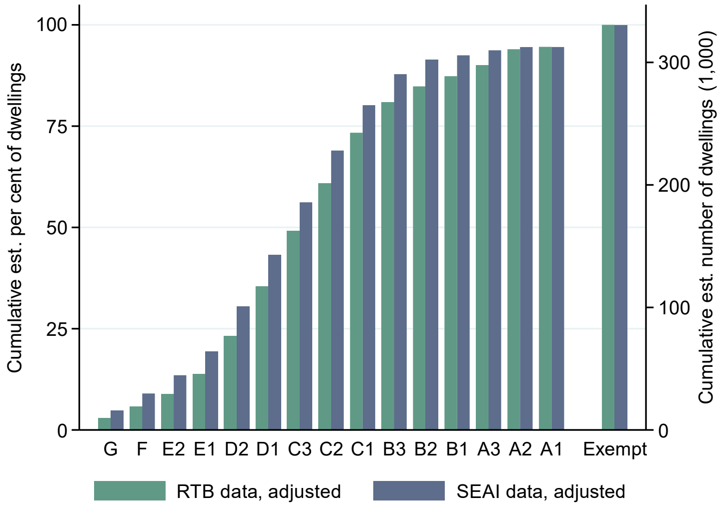


Source: Calculations using SEAI BER Research data and 2022 Census.

Figure 3.17 and Table A.2 (in the appendix) present the BER distributions for both the SEAI and the RTB datasets, adjusted using the weighting described above. In both datasets, around 60 per cent of the rental housing stock has either a C* or D* BER rating. However, even after the adjustments, the RTB data still show higher overall energy efficiencies than the SEAI data. For example, 19.3 per cent of the SEAI data have an extremely low BER of E or below, while only 13.7 per cent of the properties in the RTB sample have such a rating. On the other side of the distribution, 14.4 per cent in the SEAI data have a high BER rating, of B* or A*, while this grouping makes up 21.2 per cent of properties in the RTB data. This highlights the importance of using the SEAI data as a robustness check on our main findings. Given the RTB dataset is the most up-to-date of the two sources, and the fact that the SEAI data do not directly identify properties currently in the rental sector, our main dataset is the RTB sample. However, this also may overweight newer properties, so it is useful to have the SEAI dataset to provide a range.

FIGURE 3.17 ESTIMATED RENTAL HOUSING STOCK BY BER


Distribution


Cumulative distribution

Source: RTB Registrations data.
Note: This excludes properties without a self-reported BER rating.

CHAPTER 4

Understanding investment expenditure needs

4.1 INTRODUCTION

Having reviewed the distribution of rental properties across the building energy rating (BER) classification, the second key component for estimating aggregate costs is to examine the average costs of upgrading to a higher BER rating. In this chapter, we examine two datasets of recent energy efficiency upgrades in Ireland. Combined datasets are then used in a regression analysis to estimate the average costs of upgrades while controlling for dwelling location, type and size. These estimates are applied to all individual dwellings in the Census-adjusted Residential Tenancies Board (RTB) and Sustainable Energy Authority of Ireland (SEAI) data samples, and then aggregated to obtain overall sector-wide upgrade costs.

4.2 COST OF EFFICIENCY UPGRADE DATA

To undertake this analysis, we require data on the cost of upgrading properties to higher BER ratings, as well as information on the property characteristics and their BER ratings before and after the retrofit works.[9] This allows us to take the cost data and match these to the properties in the RTB and SEAI databases. For the purposes of this research, we use two datasets that have the required information. First, we use data from the Local Authority Social Housing Upgrade (LASHU) programme on expenditure on energy efficiency upgrades. The second dataset is from the SEAI's One Stop Shop (OSS) programme. In this chapter, we present these two datasets in more detail.

4.2.1 Local Authority Social Housing Upgrade data

As part of the Local Authority Retrofit Programme, energy efficiency upgrades to a B2 level are being undertaken on local authority-owned social housing stock. For the purposes of this research, we have been provided with data from a sample of local authorities and the upgrades undertaken in 2022. We have detailed information at the property level on the upgrades across the following local authorities: Dublin City Council (67 obs.); Dún Laoghaire–Rathdown (82 obs.); Fingal, South Dublin County Council (41 obs.); Leitrim, Tipperary, Cork County Council, Galway City, Kilkenny, Wicklow, Cavan, Carlow, Monaghan, Meath, Clare and Sligo (200 obs.). In total, information is available on 390 upgrades. For each of these upgrades, we have the following information: property type (house/apartment, floor area, year of construction); pre-upgrade BER rating; energy use statistics, post-upgrade BER; information on the type of upgrade and

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[9] Any previous expenditure on energy efficiency upgrades outside the datasets would be included in the pre-works BER rating.

any grant received (attic insulation, heat pumps, LED lighting, cavity wall etc.); and information on the total cost of the energy efficiency investment. These returns were provided by the Department of Housing, Local Government and Heritage for the purpose of this research. The information on costs in the dataset relate to the energy efficiency upgrades only and not to any other works that may have also been undertaken at the same time.

4.2.2 SEAI One Stop Shop services data

While the above LASHU data provide granular detail on the expenditure, they relate to local authority properties only. As these upgrades are likely to be commissioned and procured in bulk, it is possible that the upgrade costs may include scale efficiencies that may not be available to a typical individual or small landlords in the private market. To address this particular concern, we use a second data source. These data are taken from the SEAI One Stop Shop (OSS) programme. This programme provides a full suite of supports for a complete home energy upgrade solution for homeowners. They entail a fully managed energy upgrade, with a broad set of grants and a deduction of the grants from the cost of works upfront. The grants cover extensive upgrades across insulation, solar power, central heating and other activities.

For the purposes of this research, the SEAI have provided an anonymised micro dataset with a sample of properties that have availed of OSS grants. The data have been provided at the property level with the following variables: ownership type (approved housing body (AHB) or private owner); dwelling type; year of construction; pre- and post-works energy usage indicators; pre- and post-upgrade BER ratings; the date of the BER; and the county of the property. The total cost of the works on application is also provided. It must be noted that the SEAI cannot guarantee that this total cost figure excludes all non-energy efficiency related expenditures. OSS data do not include the floor area of the properties concerned. Instead, we use the SEAI BER research data to find properties in the same county (or in the case of Dublin the same postal routing key number), of the same type, that were built in the same decade and with a similar primary energy usage profile. The imputed floor area is calculated as an average of non-zero floor areas of all matched observations, i.e. when areas are matched on characteristics with the outcome variable being whether they have a reported floor area. They are then provided an imputation for the floor area.

4.2.3 Cost data samples comparison

We now provide summary statistics covering the data from the two cost estimate samples, and how they compare with the RTB and SEAI data discussed in Chapter 3. The total number of observations in each of these samples are presented in Table 4.1, which also includes the post-upgrade BER ratings for the properties. In total, our entire cost sample contains 1,458 observations; 705 properties are from the OSS AHB data, 363 observations are from the OSS private data and 390 are from the LASHU data. The BER ratings provided in Table 4.1 relate to the broad A*, B* and C* ratings. The majority of the upgrades are to A* ratings (56 per cent); however, this is driven primarily by private properties from the OSS dataset. The LASHU dataset has more B* than A* ratings, while for AHBs the upgrades are equally split between A* and B*.

TABLE 4.1 NUMBER OF OBSERVATIONS BY DATASET

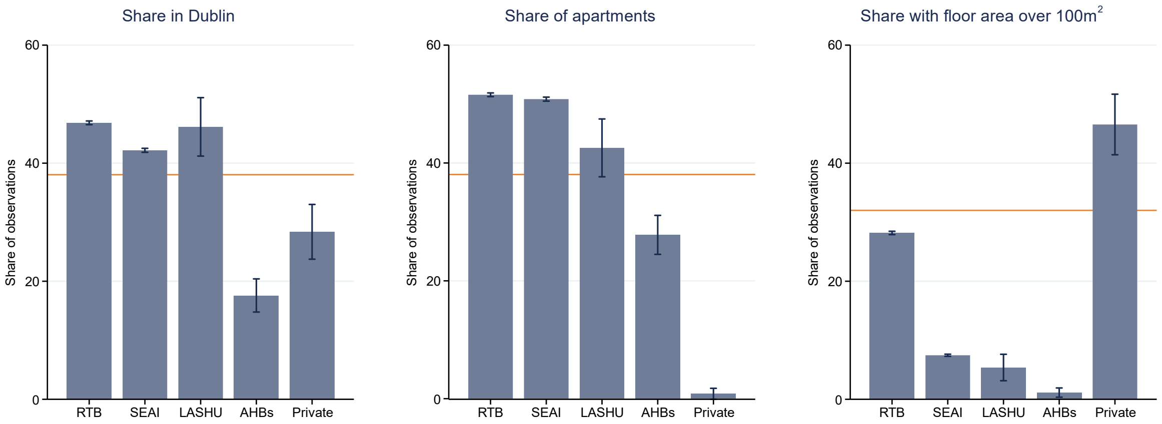
	Post-upgrade BER rating			
Dataset	C*	B*	A*	Total
OSS AHB	0	355	350	705
OSS private	0	36	327	363
Social housing	9	241	140	390
Total	9	632	817	1,458

Source: LASHU and SEAI. Only observations with non-missing cost of upgrade are included.

In terms of the types of properties and their geographic locations in these datasets, some simple descriptive statistics are presented in Figure 4.1. Three variables are included: 1) a Dublin indicator capturing the proportion of properties in Co. Dublin; 2) an apartment indicator capturing the proportion of properties that are apartments; and 3) a large dwelling indicator, which gives proportions for those properties whose floor area is above 100m^2. In all three charts, the average value from the Census is provided for reference as the horizontal line. In terms of location, the LASHU dataset is close to both the RTB and SEAI PRS databases, with between 40 and 50 per cent of the properties in Dublin across these datasets. In contrast, the AHB retrofits were primarily conducted outside of Dublin (less than 20 per cent in Dublin) and only just over 30 per cent of the OSS private upgrades were in Dublin.

Regarding property type and specifically the share of apartments, the LASHU dataset is closest to the RTB and SEAI private rental datasets, with more than 40 per cent of LASHU properties being apartments compared to 51 per cent in the RTB and SEAI samples. In contrast, the OSS data contain mostly houses rather than apartments. This is unsurprising given that the policy is targeted at homeowners, and houses are likely to be easier to retrofit on average than multi-unit dwellings with common areas. The final variable presented in Figure 4.1 relates to larger properties (defined as 100m^2 or above). The OSS private sample has a significantly higher share of large properties, at nearly 50 per cent. This likely reflects the share of houses in the data, which are larger than apartments in general. The RTB has the second highest share of large properties while the SEAI, LASHU and AHB (OSS) samples have a considerably lower share.

FIGURE 4.1 KEY CHARACTERISTICS BY UPGRADE EXPENDITURES DATASET



Source: RTB Registrations microdata, SEAI BER Research data.

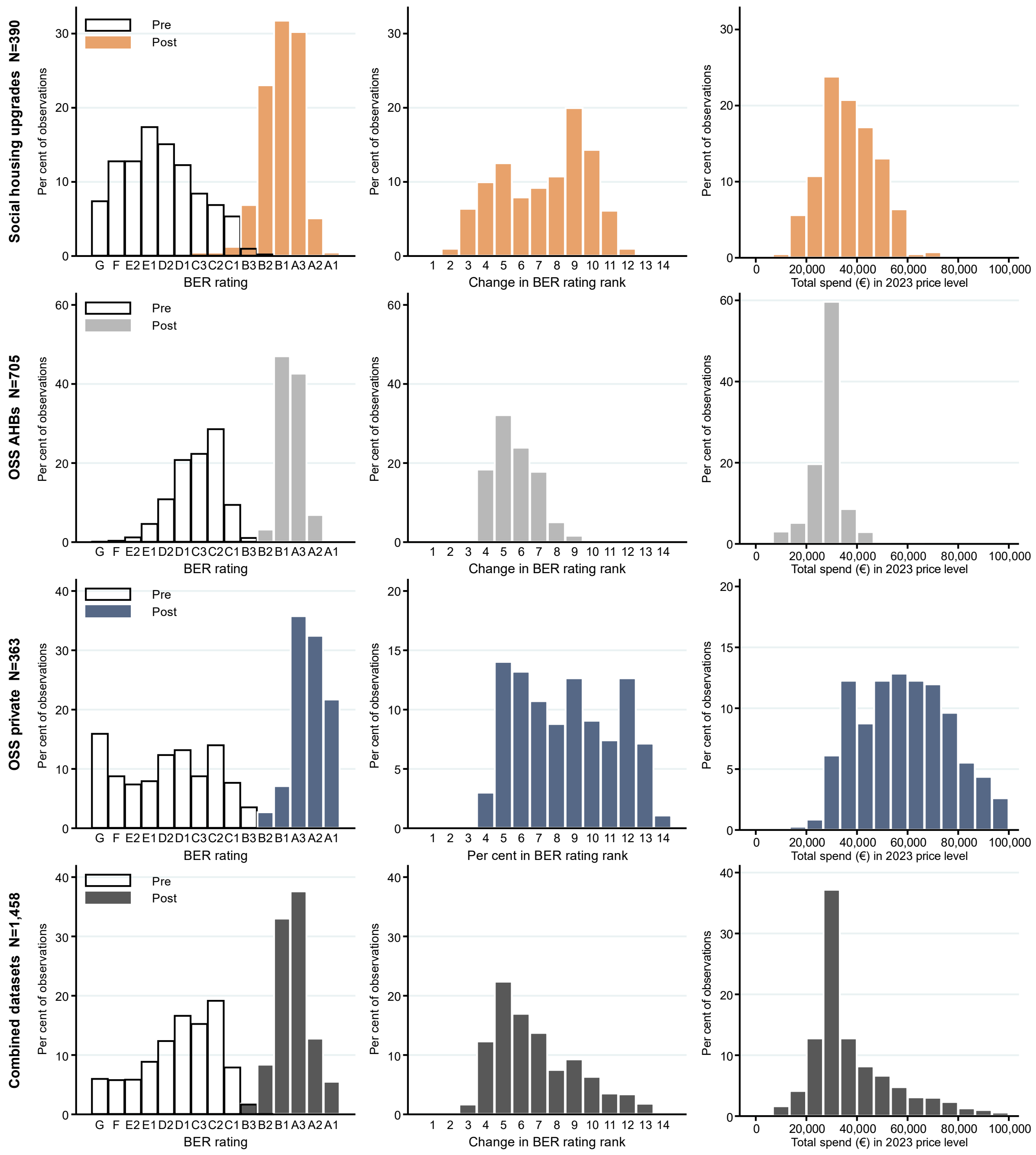
In general, comparing across these variables, we find that the OSS data for private homeowners are much more likely to concern properties outside of Dublin and larger houses, while the LASHU data in particular is more similar in the share of properties that are in Dublin and that are apartments to the RTB and SEAI private rental sector data outlined in Chapter 3. Figure 4.2 presents three key data fields across the various sub-samples and for the combined cost data. The first chart for each of the sub-samples relates to the pre- and post-BER ratings distributions. This is a critical piece of information for our research as it plots the observed changes in energy efficiency for the properties for which we have cost data.

Focusing first on the social housing upgrades data, it is clear the majority of properties had a very poor BER rating before the upgrade, with the majority of properties having an E or D rating. However, after the upgrades most properties had a B2, B1 or A3 rating; this represents quite a significant increase. For the AHB sample, the quality of the housing stock appears to have been somewhat better as the majority of properties before the upgrade were D1 or C rated. After the upgrades, most properties were B1 or A3 rated. For the OSS private sample, quite a uniform distribution across the ratings from C2 down is evident before the interventions. There were more G- and F-rated properties in this sample than in the other datasets. Following the interventions, the vast majority of the properties that came through the OSS private scheme had an A rating, with approximately 10 per cent having a B rating. This represents quite a major change in terms of energy efficiency. The final panel in Figure 4.2 includes the overall sample, with the majority of the pre-upgrade distributions populated by D-and C-rated properties while the majority of the post-work BER ratings were B2 or A3 (nearly 70 per cent).

The second figure (middle column) presented for each of the sub-samples is the distribution of the number of BER changes. The OSS private sample sees the largest jumps in terms of the BER ratings, with many properties moving up 7–12 places on the BER scale. The OSS AHB dataset has more moderate changes with, five-point increases being the most frequent jump. These more moderate rating improvements are likely related to the relatively better starting point for these properties. The LASHU data have a fairly dispersed range of rating improvements but the most frequently occurring rank jump involves nine- or ten-scale place increases. Overall, the most frequently observed increases are five to seven points, reflecting the size of the AHB sub-sample as a proportion of the overall dataset.

The final set of charts (right-hand column) presented in Figure 4.2 show the distribution of the investment costs associated with the energy efficiency upgrades. While the majority of the data presented in the samples are for properties renovated in 2022, the investment cost data have been transformed to 2023 values by deflating the data in line with the Central Statistics Office’s (CSO) cost index for materials and inputs into the construction sector. For the LASHU data, the majority of the upgrades cost between €20k and €40k per property, but the distribution does have a long tail towards the higher values with some large expenditures. For the AHB data, the majority of the expenditure is again between €20k and €40k per property, with little variation. This likely reflects the smaller range of BER rank increases seen in these data. For the OSS private sample, there is a very large spread in terms of the expenditure, and the average and median are much higher for this sample than for the others. This likely reflects the difference in housing types and the larger houses on average, as well as the bigger ratings increases (more A-rated properties after the upgrades) than the other datasets. As noted previously, it is also possible that local authorities in particular may have benefited from some economies of scale through bulk upgrades across multiple properties that individual homeowners in the OSS private sample would not have had. Finally, it cannot be excluded that some homeowners in the OSS private sample may also have included costs for some non-energy efficiency-related expenditures incurred when the works were carried out.

FIGURE 4.2 SUMMARY OF BER DISTRIBUTIONS IN EXPENDITURE DATASETS



Source: LASHU and SEAI One Stop Shot datasets.
Note: Total spent graphs do not show outlier values above €100k.

4.3 ESTIMATION OF UPGRADE COST PER DWELLING

Having profiled the energy efficiency upgrade cost datasets, our next aim is to estimate a dwelling-specific energy efficiency upgrade cost. To do so, we combine the LASHU and OSS datasets outlined above, and harmonise them to give a consistent classification of dwelling types according to Table A.1 (in the appendix). In line with the national policy target of upgrading the housing stock to a mid-B BER level, we use a sub-sample of observations that had upgrades to either B3, B2 or B1, and had a pre-upgrade rating of C or lower. This leaves a regression sample of 631 observations, of which three-quarters (481 obs.) are upgrades to B1, while 123 are upgrades to B2 and the remaining 27 are upgrades to B3. Therefore, the predicted costs of upgrade costs lean towards the higher end of the B rating. The regression sample contains only 36 observations from the privately owned OSS sub-sample, because the majority of these upgrades were to A* level and are therefore omitted from our estimation. The dependent variable is always the log of total costs of the upgrade in 2023 prices. When results are reported (e.g. in Figure 4.3), the logarithmic values are converted back into euros. It is important to note that the regressions are used to estimate the average cost of the energy efficiency upgrade. The actual costs for individual properties will deviate from this expected value – some being lower and some higher. Due to limited data, both in terms of the sample size and observable characteristics, the regression models cannot account for every possible determinant of the upgrade costs. Despite the diversity of the housing stock, when the predicted values are aggregated in Chapter 5, it is likely that these individual differences will tend to counterbalance each other. Consequently, even if individual estimates diverge, the means are still reliable estimates for the aggregate costs.

Our first approach is to estimate the costs as a series of dummy variables, where each dummy represents one of the nine pre-upgrade BER ratings, from G to C1. This approach shown in equation Reg.1 is numerically equivalent to estimating average log costs for every pre-upgrade BER rating. The predicted costs for each dummy are shown in Figure 4.3, and the full results are in Table A.4 (appendix). The estimated upgrade costs range from €40k for an F/G rating, to around €26k for a pre-works BER of D or C.

$$lnCost_i = \beta_0 + \sum_{j=H}^{C1} \beta_j (PreBER = j)_i + \varepsilon_i \tag{Reg.1}$$

$$\begin{aligned} lnCost_i = \beta_0 + \sum_{j=H}^{C1} \beta_j (PreBER = j)_i \\ + \boldsymbol{\beta X^T} + \varepsilon_i \end{aligned} \tag{Reg.2}$$

In Equation Reg.2 additional control variables, represented by vector X, are added to the model. The three control variables are: a) a Dublin dummy, which takes the value 1 if a dwelling is located in County Dublin and 0 otherwise; b) an apartment dummy which equals 1 if the dwelling is an apartment and 0 if the dwelling is a house;[10] and c) a large-sized dummy which equals 1 if the dwelling is larger than

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[10] See Table A.1 for details on dwelling types across the datasets.

100m^2 and 0 otherwise. All these dwelling characteristics are also reported in the RTB and SEAI datasets, which allows us to predict dwelling-specific costs of the upgrade before aggregating.

The results in Table A.4 show that upgrades in Co. Dublin are around 25 per cent more expensive than elsewhere and that apartment upgrades are 20–25 per cent cheaper than houses. The dwellings above 100 m^2 are around 15 per cent more expensive to retrofit; however, this relationship is statistically not as strong. The magnitudes of these relationships are similar in all other model specifications. Adding these three variables does not change the average upgrade costs much, though they significantly improve the predictive power of the model. In the remaining four specifications, the relationship between the costs and pre-upgrade BER is modelled as a continuous polynomial function. The $PreBER$ rating is converted into a numerical variable $\widetilde{PreBER}$ between 0 and 1, with an equally spaced interval between each pre-works BER:

$$\widetilde{PreBER} = \begin{cases} 0 & \text{if } PreBER = H \\ 1/8 & \text{if } PreBER = F \\ 2/8 & \text{if } PreBER = E2 \\ \vdots & \vdots \\ 1 & \text{if } PreBER = C1 \end{cases}$$

In Reg.3 the costs are modelled as a quadratic function and in Reg.4 as a cubic function of this variable. This approach relies on the assumptions that nearby BER ratings will involve similar upgrade costs. This gives better predictions when there are relatively few observations in the pre-upgrade rating,[11] and reduces the risk of overfitting.

$$lnCost_i = \beta_0 + \beta_1\widetilde{PreBER}_i + \beta_2\widetilde{PreBER}_i^2 + \boldsymbol{\beta X^T} + \varepsilon_i \qquad \text{(Reg.3)}$$

$$lnCost_i = \beta_0 + \beta_1\widetilde{PreBER}_i + \beta_2\widetilde{PreBER}_i^2 + \beta_3\widetilde{PreBER}_i^3 + \boldsymbol{\beta X^T} + \varepsilon_i \qquad \text{(Reg.4)}$$

Panels (3) and (4) in Figure 4.3 show the estimated costs, which are broadly in line with results (1) and (2). The costs are higher for upgrades from G at €43.5k as well as for upgrades from D and C, at about €28k. However, the costs for F and E are slightly lower than in regression models (1) and (2) at €32k–38k. To compare the models we calculate the Akaike information criterion (AIC) and the Bayesian information criterion (BIC), which are standard measures of the predictive power of the model. Both the AIC and BIC show the quadratic and cubic equations have better predictive power compared to the series-of-dummies approach.[12]

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[11] For example, there are only 33 observations with a pre-upgrade BER rating of E2.

[12] Note that for both AIC and BIC, lower values means better predictive power.

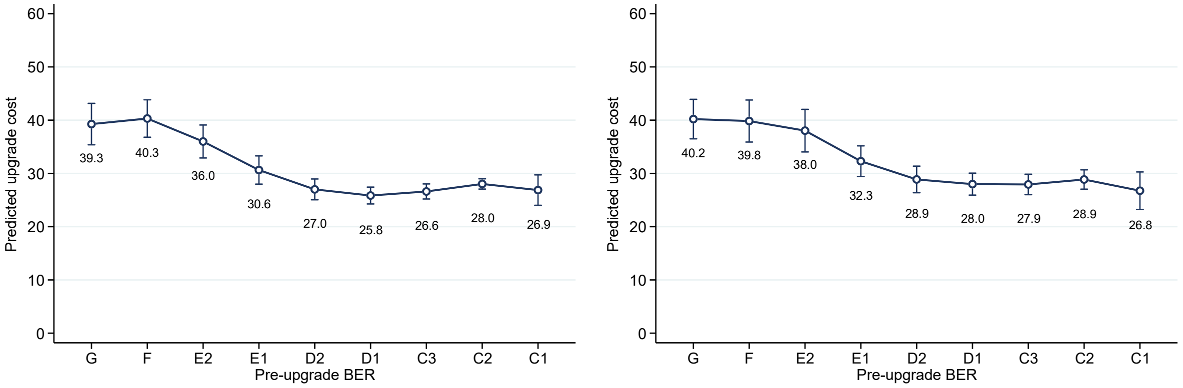
The remaining two regression models use equation Reg.3, but are estimated using quantile regression. Model (5) estimates the expected median cost (50th percentile). The predicted values of the medians are again similar to the previous estimates of the mean cost of upgrade. Finally, model (6) estimates the 75th percentile of the upgrade costs as an upper-bound estimate of the upgrade costs. The fitted values are accordingly higher and they range from €32.7k to €49.3k. This scenario can be seen as a useful upper bound, which could occur under a persistent and elevated high construction inflation environment or excessive capacity constraints in the construction sector leading to price increases.

In several of the regression models, the estimated relationships are not always strictly decreasing. For example, based on Reg.2 the estimated mean upgrade costs from C1 are €600 higher than an upgrade from the less energy efficient C2 BER rating. This is due to small numbers of observations in the data, especially for C1 as only 12 dwellings in our data got an upgrade from C1 to B*. These non-monotonic estimates tend to be fairly small and often not statistically significant. Therefore, we do not make any further functional-form assumptions or use nonlinear regression models to address this issue.

FIGURE 4.3 ESTIMATED AVERAGE COSTS OF UPGRADE BY PRE-UPGRADE BER IN €1K IN 2023 PRICES

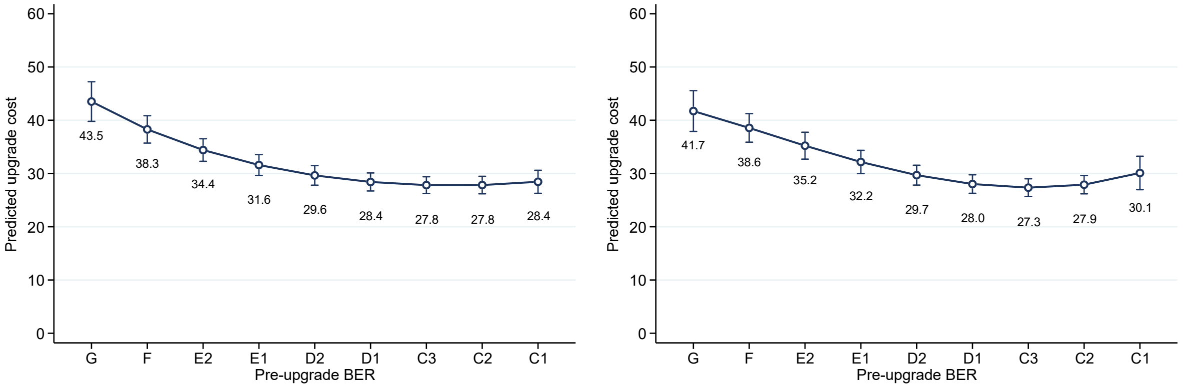
(1) Dummies without controls

(2) Series of dummies



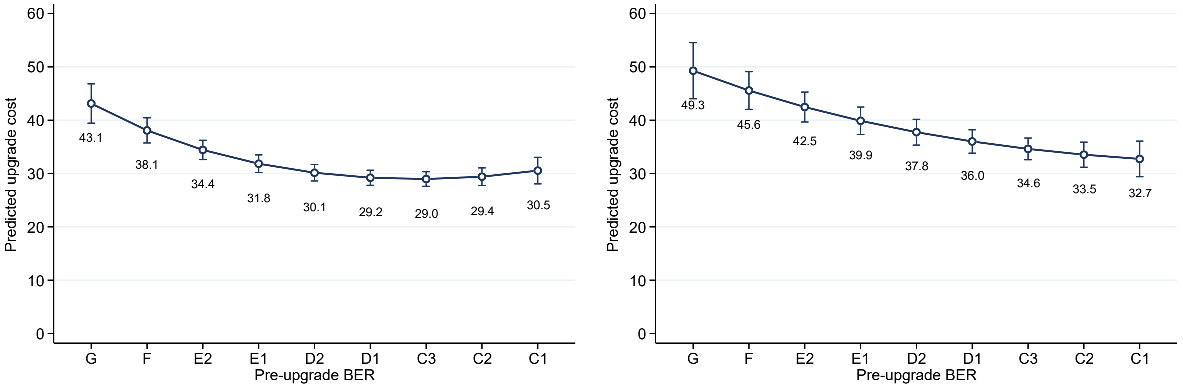
(3) Quadratic fit

(4) Cubic fit



(5) Quantile regression, median

(6) Quantile regression, p75



Source: LASHU and SEAI OSS datasets.

Notes: Predicted values at Dublin dummy=0.38, apartment=0.40, large=0.32. 95% confidence intervals. Full estimation results table are in Table A.4 (appendix).

4.4 TOWARDS AN AGGREGATE COST OF PRS DWELLING UPGRADES

The next step in our analysis is to develop an aggregate overall cost for the PRS of undertaking energy efficiency upgrades. To do this, we use the combination of datasets and estimates of the cost structures in the previous two chapters. Our general methodology is as follows: for each dataset that measures the BER profile of the sector (RTB and SEAI research database), we have estimated a property-specific cost for each dwelling. We then aggregate this cost with the Census weights to obtain a total renovation cost. The estimation of the costs across different methodologies has been outlined in the previous section.

As mentioned above, for the purposes of this analysis, we limit ourselves to an upgrade target in line with the National Retrofit Plan, which aims for B2 standard dwellings as a key target. As discussed above, we therefore use the cost data in our estimates to upgrade all properties from their current BER rating to a minimum of the average cost for a B* property in our data. Given the vast majority of our B* upgrade cost data relates to B1 or B2 properties, our upgrade scenario in essence moves all properties to a mix of B2 or B1 levels. These costs are then aggregated across all properties that are currently C rated or below.

An illustration of our aggregation process can be seen in Table 4.2. The table draws on the RTB tenancy registrations data sample as described in Chapter 3. The estimates of cost of upgrade are taken from the quadratic fit model (Reg.3) described above. Because this model has the best predictive power it is used as a benchmark model.

In Table 4.2, the estimated distribution of current BER ratings, adjusted for non-reported values and Census weighted, is presented in column (2). Column (3) is the proportion of the totals excluding A/B and BER-exempt rental properties. Naturally, for this scenario any property that is already energy efficient does not require an upgrade and will not be included in further calculations. Thus, the total number of properties simulated for upgrade is 242,467.

In column (5), the average cost of the upgrade per property is provided for each of the BER groups. For example, the average upgrade costs to B* for all properties is just over €30k but it ranges across the starting BER; the average upgrade cost for G-rated properties is €43k and this declines to €28k for C-rated properties. The total cost for each group is presented in column (6) with the proportion of the total cost in column (8). In this scenario, the total sector upgrade costs are approximately €7.3bn. Just under €5bn of this total relates to properties that are currently D or C rated. Although the average cost is lower than for low-efficient G/F/E rated properties, there are many more mid-efficient properties overall.

TABLE 4.2 EXAMPLE USING RTB DATA AND QUADRATIC FIT UPGRADE COSTS

	Dwellings			Upgrade cost				
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Current BER	Est. number	%	Cum. %	Mean (€1,000s)	Total (€mil)	Cum. (€mil)	Total (%)	Cum. (%)
G	9,663	4%	4%	43.5	421	421	6%	6%
F	9,523	4%	8%	38.9	371	791	5%	11%
E2	10,239	4%	12%	34.8	357	1,148	5%	16%
E1	16,005	7%	19%	31.7	507	1,655	7%	23%
D2	31,136	13%	32%	29.9	932	2,587	13%	35%
D1	40,708	17%	48%	28.9	1,176	3,763	16%	51%
C3	45,029	19%	67%	28.3	1,274	5,037	17%	69%
C2	38,859	16%	83%	28.3	1,100	6,137	15%	84%
C1	41,306	17%	100%	28.9	1,194	7,331	16%	100%
For upgrade	242,467	100%	100%	30.2	7,331	7,331	100%	100%
B*	46,145	Dwellings not included in upgrade cost calculations.						
A*	23,925							
Exempt	18,095							
Total	330,632							

Notes: Columns 2–4 number of dwellings based on RTB data, adjusted for missing BER ratings, population-weighted with number of dwellings from the Census, and excluding dwellings in protected superstructures (row 'Exempt').
Column (5) shows average costs in €1k in 2023 price levels, using equation Reg.3 model and combined data from LASHU and the SEAI OSS service. These averages account for dwelling characteristics (apartment, Dublin-based, large-size dummies), and therefore differ slightly from representation in Figure 3.3 where these characteristics are held constant across all pre-upgrade BER ratings.
Figures in columns (6) and (7) are in million euros.

Table 4.3 presents the range of aggregate estimates calculated across all six models tested in the previous chapters and across both housing stock datasets, the RTB and SEAI data. In all figures and charts, the cost data are provided in 2023 prices and assume upgrade technologies and associated investments costs in line with those in the micro datasets above. The most parsimonious cost equation specification, which does not contain any control variables, gives a total upgrade cost in the RTB data of €6.9bn while the upgrade cost in the SEAI dataset is €7.7bn. When controls (floor area, Dublin and dwelling type) are included, the costs increase to €7.3bn and €7.85bn using the RTB and SEAI datasets respectively.

TABLE 4.3 ESTIMATED AGGREGATE COSTS OF UPGRADE TO B* FOR ALL G-C1 DWELLINGS (€MN)

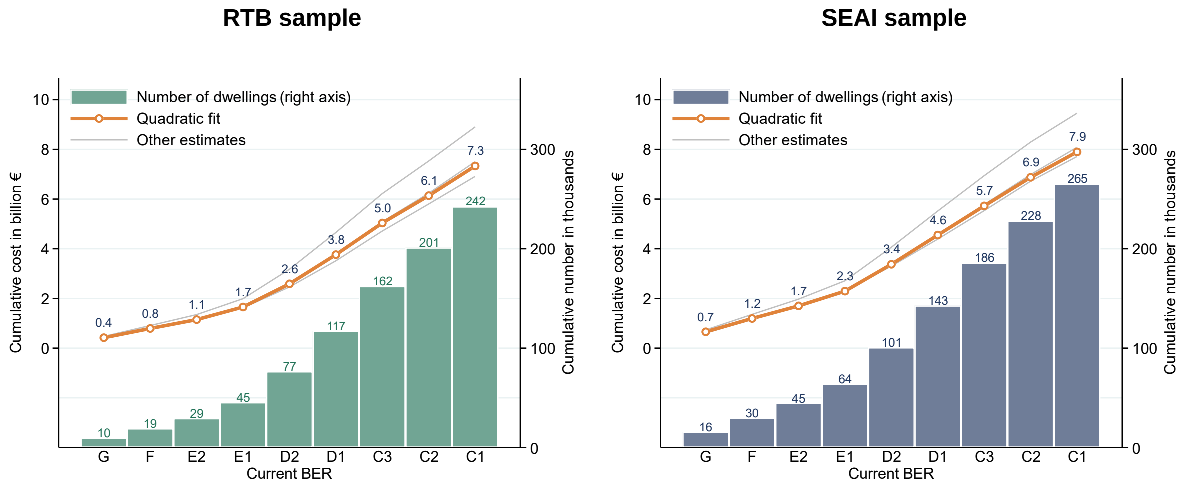
Cost estimation approach	BER from RTB data	BER from SEAI data
(1) Series of dummies	6,912	7,713
(2) Dummies + controls	7,290	7,853
(3) Quadratic fit	7,331	7,897
(4) Cubic fit	7,367	7,938
(5) Quantile reg p.50 (median)	7,505	8,084
(6) Quantile reg p.75	8,903	9,456

Source: Estimates excluding BER-exempt heritage buildings. See Table A.5 for estimates on the entire sample.

Our benchmark specification is the quadratic fit approach (Reg.3). Under this modelling framework, the total cost using the RTB data is just over €7.3bn and is just under €7.9bn using the SEAI data. Alternative modelling strategies, using a cubic fit and quantile regression at the median, provide similar estimates to those under the benchmark scenario. A final sensitivity that we present uses a quantile regression on the cost data at the 75th percentile. This is a useful higher bound on the cost estimates as, rather than coefficients at the mean for each property, it applies the cost structure from the 75th percentile of the cost data. The estimates in this scenario rise from €8.9bn in the RTB sample to €9.4bn in the SEAI sample. This scenario can be seen as a useful upper bound, which could occur under a persistent and elevated high construction inflation environment or excessive capacity constraints in the construction sector leading to price increases.

Figure 4.4 presents a cumulative view of the cost of upgrading the properties, as well as the number of properties (after the Census weights are applied) across the BER distribution. Both the RTB and SEAI samples are presented. The cumulative number of properties is higher in the SEAI sample (265,000) relative to the RTB sample (242,000) as the initial BER distribution has more C1 and below properties in the SEAI sample. The cost estimates are presented for the benchmark quadratic model (model (3) in Table 4.3). The average of the other cost estimates is also presented in the grey line. It is clear that the majority of the cost is coming from properties of a D and C rating rather than the lowest ratings due to a concentration of properties in this part of the distribution.

FIGURE 4.4 CUMULATIVE COSTS AND NUMBER OF DWELLINGS TO UPGRADE ESTIMATES



Notes: Estimates excluding BER-exempt heritage buildings. See Table A.5 for estimates on the entire sample.

In all of these scenarios, it must be noted that the estimated investment costs should be seen as a static analysis, valued at present. It does not take into consideration any second-round effects that may occur on prices and quantities if these investments occurred simultaneously.

CHAPTER 5

Investment barriers and the landlord structure

The analysis in Chapter 4 suggests major investment will be required to meet the targets in the National Retrofit Plan for the residential rental sector. A major determining factor as to whether such investments will materialise concerns the barriers faced by landlords in undertaking investment (supply-side constraints) and their willingness to make the investments (demand-side factors). The balance of these factors is likely to depend on the type of landlord concerned. This could pose a range of challenges given the characteristics of landlords such as their age, access to finance, investment horizon etc. For example, larger, commercial landlords face different financing conditions and financial capacity to those of smaller household landlords. They also face differing incentives around the payback period and rate of return on any residential investment activity. Furthermore, drawing on Residential Tenancies Board (RTB) research (RTB, 2023), it can be seen that the majority of small landlords in Ireland are so on a part-time basis, have at least one other occupation, and over 79 per cent of them are over the age of 45. Approximately 49 per cent own outright the dwelling they rent out. Of this group, in 2022, approximately 57 per cent were unsure, likely or very likely to sell their property, which suggests their investment appetite is limited. Understanding how the landlord structure impacts investment activity is critically important in determining how likely it is that energy efficiency upgrades will happen.

With this in mind, the rest of this chapter aims to explore a number of questions in more detail by focusing on household landlords. This group are most likely to face substantial supply- and demand- side barriers to investment. Using detailed microdata from the Central Statistics Office's (CSO) Household Finance and Consumption Survey (HFCS) and the EU cross-country Survey on Income and Living Conditions (SILC), we aim to profile the household landlords in Ireland to answer the following questions:

- Who are these landlords in a demographic context (age, incomes etc)?
- What financial resources have these landlords at their disposal in terms of liquid assets (cash and cash equivalents) and other wealth?
- How highly leveraged are these households and do they have collateral available to fund potential borrowings?
- Financially, are these households under financial strain or distress?
- Can these households afford simulated hypothetical investments?

By answering these questions, we can improve our understanding of the capacity of household landlords to decide to invest in decarbonisation.

5.1 DATA AND DEMOGRAPHIC PROFILE OF HOUSEHOLD LANDLORDS

5.1.1 Data overview

The main dataset used for this analysis is the Household Finance and Consumption Survey (HFCS), conducted by the CSO. The HFCS is a household survey coordinated by the European Central Bank under the guidance of the Household Finance and Consumption Network, which was established in 2006. The aim of the survey is to collect micro-level information across Euro area member countries (plus a few other EU countries) on the assets and liabilities of households, as well as a range of additional information regarding the economic position and economic decisions of the household. The Irish HFCS has had three waves so far: April 2013, December 2018 and March 2020. In this report, we analyse the 2018 and 2020 data.

In general, the data are collected from randomly selected households across a common set of core output variables, which are delivered across all participating countries. Individual countries are then free to expand to a non-core element if additional information is required. The collection of the core questionnaire data is aimed at producing consistent cross-country comparisons, although there needs to be some flexibility in the formulation of these questions for them to be comparable across countries. The survey collects information on each household across various aspects of demographics, income, financial and other assets, liabilities, and expenditure on durables and non-durables. While there are standardised questions in the HFCS survey to determine the best respondent to answer the questions on household finances (the ‘financially knowledgeable person’), each person in the household is interviewed to some extent.

The HFCS is split into three separate datasets: the ‘H’ dataset, the ‘P’ dataset and the ‘R’ dataset. The H dataset contains variables relating to the entire household and is answered by the ‘household reference person’, while the P and R datasets contain personal variables, which are answered by individual members of the household. This means that the H dataset is conducted at a household level, and the P and R datasets are both conducted at a personal level within each household. Therefore, before merging the personal datasets with the household dataset, we aggregate the personal files so that they present at a household level by generating a head of household indicator (the person in the household who reports the highest annual income). We then merge the two personal datasets with the household datasets by household ID and wave. Many of the variables of interest, for example total household income, have to be generated manually.

As with any household survey, missing data can be an issue due to non-response. The national authority with responsibility for undertaking the HFCS in each jurisdiction must attempt to deal with this issue by using multiple imputation, i.e. using data for other households to establish a predicted value for the missing information. To get a robust measure, this process is repeated five times by the responsible agency, and a measure combining all five imputations is used in any analysis.[13] To use information from all five imputations, we collapsed the merged dataset taking the mean for each variable by household and wave.

To capture outliers, we cut the top 1 per cent and bottom 1 per cent from the sample. We also removed the observations where household income was negative. To compensate for the unequal probability of the household being selected into the sample and differential unit non-responses, the HFCS dataset provides a weight to use during the analysis.

5.1.2 Demographic characteristics of household landlords in HFCS

After cleaning the dataset, we had a final sample size of 10,483 households, with 4,670 and 5,813 in 2018 and 2020 respectively. Every household in the sample had a household main residence, which is the dwelling where members of household usually live. Some households owned ‘other’ properties. These other properties include houses, apartments, offices, hotels, farms and land. As depicted in Figure 6.1, 19 per cent of households in the sample owned a property or properties other than their household main residence (20 per cent in 2018 and 19 per cent in 2020) (Figure 6.2). However, not all additionally owned properties are rented. Out of the entire sample, 10 per cent of households leased or rented their other property or properties to either a business or to people outside of their household (10 per cent in 2018 and 9.5 per cent in 2020).

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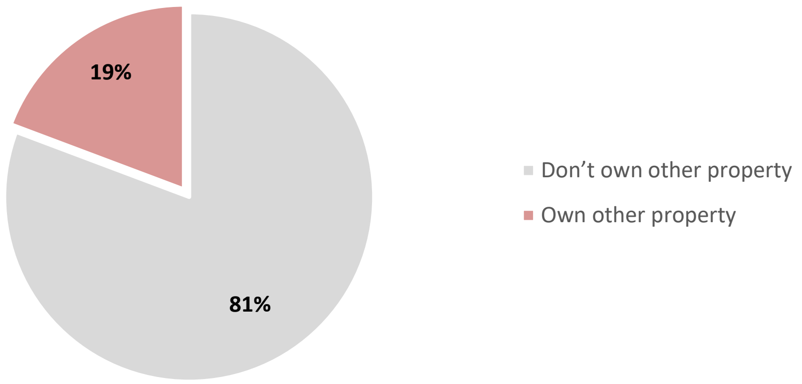
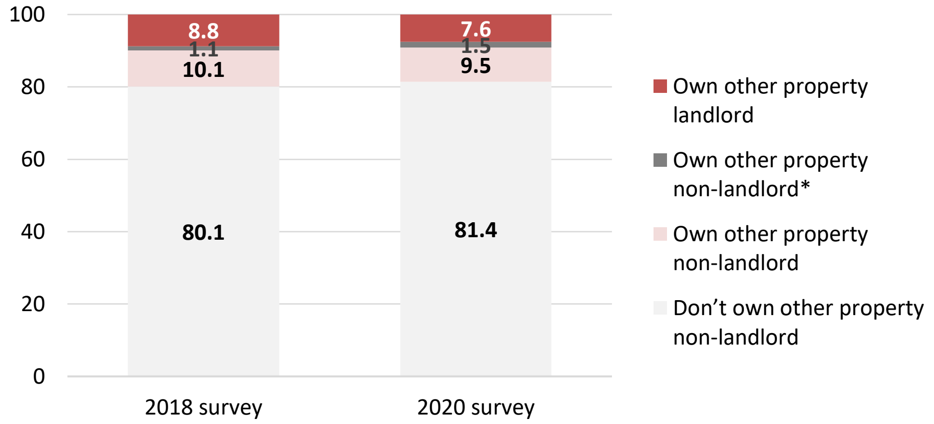
[13] For more information, please see the ECB guidelines for this: https://www.ecb.europa.eu/pub/pdf/scpsps/ecb.sps35~b9b07dc66d.en.pdf.

FIGURE 5.1 PROPORTION OF HOUSEHOLDS THAT OWN OTHER PROPERTIES APART FROM MAIN RESIDENCE



Source: Analysis based on CSO HFCS data.

FIGURE 5.2 PER CENT OF HOUSEHOLDS OWNING OTHER PROPERTY BY YEAR

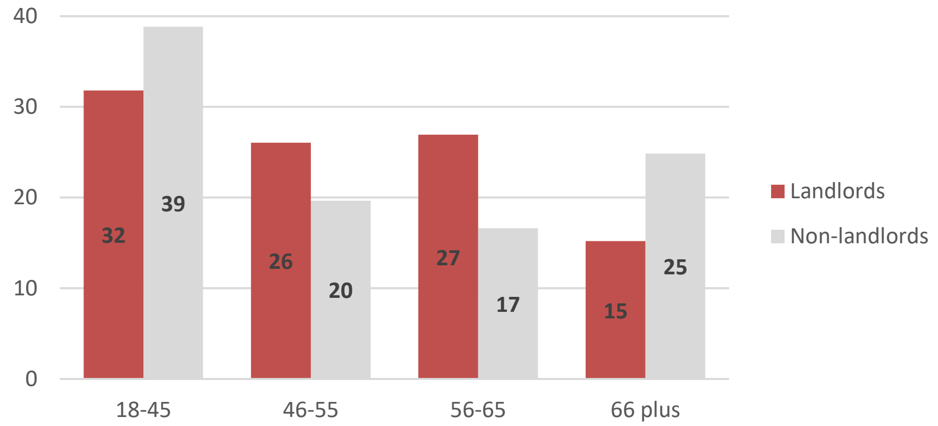


Source: Analysis based on CSO HFCS data.
Notes: *Households that rent out non-residential properties are therefore not counted as landlords in this report.

While there can be many types of landlords, in this report we are only interested in landlords of residential properties (e.g. excluding agricultural land and owners of commercial use properties). When referring to a landlord, we are therefore referring to households that a) owned a property other than their main household residence, b) rented or leased that property, and c) the property had to be either a house, flat or an apartment building. When referring to non-landlords, we are discussing those who either do not own any additional properties, or if they do own additional properties, they either do not rent/lease them or their properties are not houses or apartment buildings. In 2020, 7.6 per cent of households in the sample were landlords according to this definition. In terms of how many properties these landlords owned, 57 per cent owned one rental property, 28 per cent had two rental properties and 15 per cent had three or more rental properties.

In terms of the age profile[14] of landlords (Figure 6.3), there is a greater share of residential landlords over the age of 45 (68 per cent) than non-landlords (61 per cent).[15] To provide a more granular split of the data, there are more landlords aged between 46 and 65 years (53 per cent) than non-landlords (36 per cent).

FIGURE 5.3 COMPARING LANDLORDS AND NON-LANDLORDS: AGE



Source: Analysis based on CSO HFCS data.

Data provided by the CSO from their *Rental market in Ireland 2021* report show that many of the older landlords have multiple properties (Figure 5.4). The age of the landlord may impact their decisions around investment expenditure on energy efficiency. For example, bank credit access may get more difficult with age, and on retirement, as credit is rationed through a shorter loan term being available and less income to cover repayments; i.e. the households are in that period of their lifecycle in which they are running down accumulated financial assets. Older landlords may have a shorter investment horizon for holding the asset, which may affect the net present value of any investment. The assessment is likely to depend on the cost of the investment, the availability of grants or subsidies (which is outside the scope of this report) and existing BER. It is also possible that the ability to re-price the rent through the Rent Pressure Zone legislation after energy efficiency upgrades would incentivise them to make the expenditure. The degree of compliance and monitoring involved could also factor in their decision-making process.

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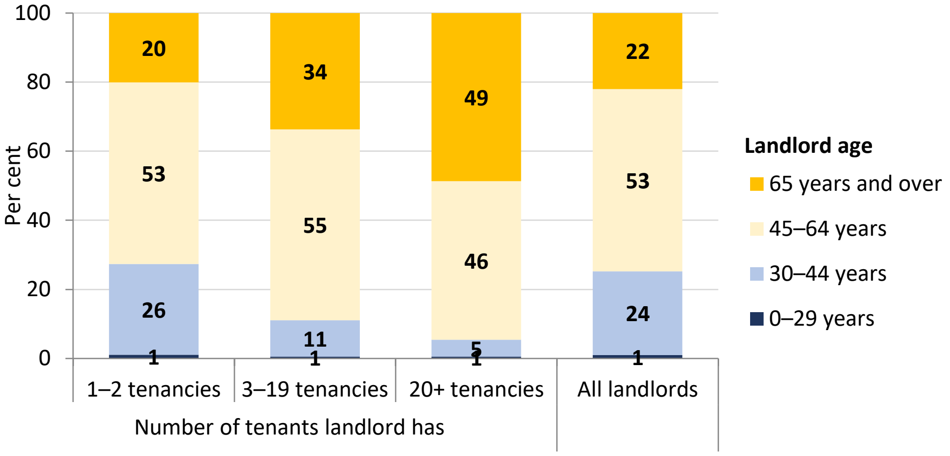
[14] Ages presented refer to heads of household. [15] Ages presented refer to heads of household.

[15] Ages presented refer to heads of household.

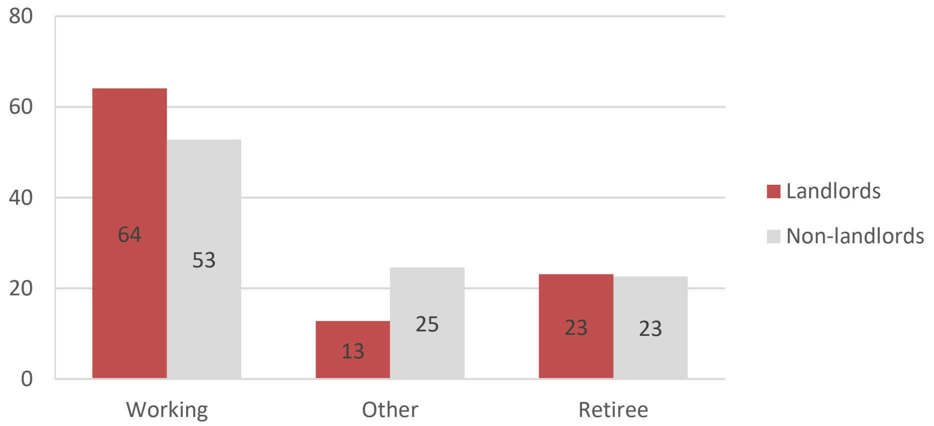
FIGURE 5.4 LANDLORD AGE BY NUMBER OF TENANCIES



Source: CSO data based on RTB tenancy registration data.
Notes: The RTB data only relate to new tenancies and Part 4 renewals as the RTB did not collect annual registrations for the period which the CSO undertook the analysis.

Finally, we compare the employment status of landlords and non-landlords. Employment status is split into three groups; working, retiree or ‘other’, where other refers to those who are unemployed, on temporary leave, students, in the military, fulfilling domestic services, or permanently disabled (Figure 6.5). Almost one-quarter (23 per cent) of both landlords and non-landlords were found to be retired. More landlords worked (64 per cent) than non-landlords (53 per cent). Nearly double the share of non-landlords were in the other category compared to landlords, at 25 and 13 per cent respectively.

FIGURE 5.5 COMPARING LANDLORDS AND NON-LANDLORDS: EMPLOYMENT



Source: Analysis based on CSO HFCS data.

5.1.3 Overview of income and wealth

One important aspect of investment capacity is income. We examine both landlord employment income and total earnings – i.e. including income from stocks and bonds, pensions, rent, social transfers and other sources of household income.

Table 5.1 below contains the weighted average and median level of income for landlords from the HFCS dataset for the year 2020. The average total household income for landlords was approximately €110,816. The median household income for landlords was €92,400.

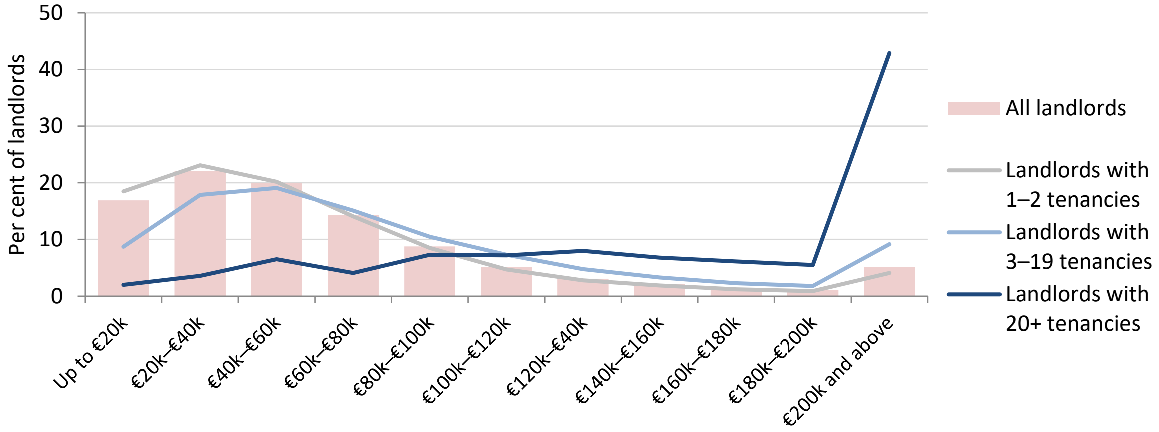
TABLE 5.1 SUMMARY OF LANDLORD ANNUAL HOUSEHOLD INCOME DATA – SURVEY YEAR 2020

	Mean	Median
Landlords	€110,816	€92,400

Source: Analysis based on CSO HFCS data.

Another useful aspect to consider in this context is the number of properties owned by landlords across the income distribution. These are presented in Figure 5.6, which draws on the CSO's *Rental market in Ireland 2021* report.

FIGURE 5.6 INCOME DISTRIBUTION OF RTB LANDLORDS BY LANDLORD SIZE



Source: CSO data based on RTB tenancy registrations data.

These data show that landlords with more than 20 tenancies have considerably higher incomes than those with fewer tenancies. This again highlights the potential financial capacity challenge for lower income, single or 'few property' landlords.

It is important to note the difference in income distribution across the CSO dataset and the HFCS data. As the CSO only include earned income data, they likely do not capture income from wealth that could enhance the income position of landlords. Furthermore, they only consider new active tenancies as per the RTB dataset; therefore the data are biased towards only considering those tenancies that turn over more frequently. The ESRI/RTB Rent Index (as well as other market monitoring reports such as Daft.ie) show falling turnover in the market, meaning that new tenancies are becoming less representative of the entire market over time. For example, in 2007–2008, over 100,000 new tenancies were registered every year with the RTB. This had dropped to 64,000 in 2021.

Another critical factor in the ability of landlords to invest in their properties is the annual return they receive in rent. These cash flows are the yield that could be used to offset and cover any investment expenditures, and are therefore a critical component of any assessment of investment feasibility. Table 5.2 presents the mean and median landlord income from rental properties for the years 2018 and 2020. The average rental income in 2020 was approximately €20k per annum, while the median was €14.4k. These had increased by 14 per cent and 4 per cent respectively over this period.

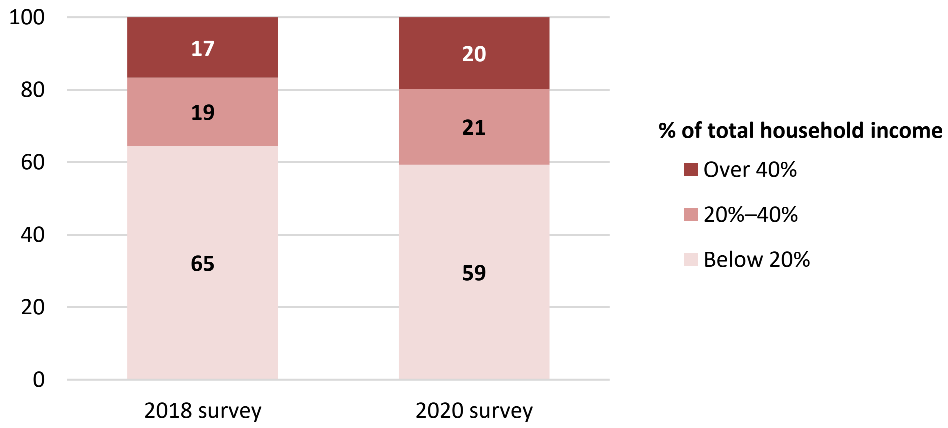
TABLE 5.2 SUMMARY OF LANDLORD ANNUAL RENTAL INCOME DATA – SURVEY YEARS 2018/2020

Survey year	Mean	Median
2018	17,627	13,800
2020	20,243	14,400
% Difference	+14%	+4%

Source: Analysis based on CSO HFCS data.

Given that landlords of residential properties may combine earned and non-earned income when considering their letting, it is useful to consider what proportion of their total income comes from the rental property. An examination of rental income shows that the mean share of rental income as a proportion of total household income for landlords was 24 per cent, i.e. on average, rental income makes up approximately one-quarter of landlords' income. Figure 5.7 presents the proportion of landlords against the share of their income that comes from rental income. A majority of landlords earned less than 20 per cent of their income from rental sources.

FIGURE 5.7 PROPORTION OF LANDLORDS BY RENTAL INCOME AS % TOTAL INCOME



Source: Analysis based on CSO HFCS data.

A key factor in terms of the overall ability of landlords to invest in energy efficiency technology is the level of wealth that they hold. This in particular relates to financial wealth or deposits that can be easily deployed for capital investment purposes. In this section, we draw on the data from the HFCS on wealth structures to provide a summary overview of the resources available to landlords.

In the HFCS, a number of wealth variables can be derived. Table 5.3 below presents the definitions of the wealth variables that we use in the analysis.

TABLE 5.3 DEFINITIONS OF WEALTH VARIABLES

Variable	Definition
Real assets	Collective value of household main residence, properties, vehicles, self-employment businesses and valuables.
Financial assets	Collective value of any stocks, bonds, mutual funds, savings accounts, managed accounts, non-self-employment businesses, sight accounts, private lending, voluntary pensions and 'other' assets.
Total assets	Value of real assets and financial assets.
Net wealth	Total assets – total outstanding balance of a household's liabilities.

Table 5.4 presents the summary statistics of the main wealth variables for landlords. Median total assets of landlords were just over €528k, with a median net wealth of €392.5k. However, this relates to wealth from the principle private residence as well as investments. In terms of financial assets, the median was €31.5k.

TABLE 5.4 SUMMARY OF MAIN WEALTH VARIABLES

	Landlord	
Variable	Mean (€)	Median (€)
Total assets	922,800	528,094
Net wealth	867,757	392,519
Real assets	772,685	416,100
Financial assets	83,834	31,551

Source: Analysis based on CSO HFCS data.

One important aspect to consider when thinking about the issue of household investment is the level of savings. Savings are included above in the 'financial assets' category. However, due to liquidity, it is useful to consider them separately. The data are presented below in Table 5.5.

TABLE 5.5 SUMMARY OF SAVINGS (€)

	Mean (€)	Median (€)
Landlord	37,148	17,000
Non-landlords	19,746	6,460
Total	**21,008**	**7,000**

Source: Analysis based on CSO HFCS data.

The mean level of savings for landlord households is €37k and the median is €17k. This suggests that many landlords would have to obtain credit in order to invest substantially in their real estate as the investment costs for their rental properties would likely be much more than this, based on the costs presented in Chapter 4.

In addition to their wealth, landlords are often also carrying considerable debts, relating to their investment borrowings but also their own residential dwelling. The data in Table 5.6 present the level of debt and the current loan-to-value ratios of landlords. The mean liabilities carried by landlords were just over €200k in 2020, with a median of €104k.

TABLE 5.6 SUMMARY OF INDEBTEDNESS

	Mean	Median
Summary of total outstanding Balance on household liabilities (€)	201,138	104,032
Portfolio loan-to-value ratio	37.8%	33.1%

Source: Analysis based on CSO HFCS data.

Given that it seems a distinct possibility that many landlords would require collateralised credit to finance investment into improvements in their properties, current loan-to-value ratios are examined to explore the extent of collateral available in the properties. These loan-to-value ratios are calculated at the portfolio level, including the main residential dwelling, and include all mortgage loans in the numerator. The mean and median figures are presented in Table 5.6. These landlords have a mean loan-to-value ratio of 38 per cent. This represents the amount of outstanding debt on properties as a proportion of the value of those properties. Therefore, on average, landlords have outstanding debt worth less than 40 per cent of the value of their properties. Hence, it is possible that some landlords would be able to attain financing for improvements. This would depend, however, on the level of investment required, and the term of the loan that would be available to the borrower (likely linked to their age). The issue of financial capacity is discussed below.

5.2 SIMULATING HYPOTHETICAL FINANCING GAPS

Having reviewed the income and wealth position of Ireland's household landlords, the aim of this section is to get a clearer assessment of the ability, and willingness, of landlords to undertake investments in their properties. In the first exercise we undertake, we use the information on wealth from the HFCS survey and combine this with hypothetical investment expenditures, calibrated from the data in Chapter 4, to simulate in the microdata the extent to which households could cover this expenditure through their own financing resources. Second, for those households that have insufficient resources available, we then explore their ability to finance and cover those expenditures using commercial financing. This can provide insight into the ability of households to bridge the gap. It must be noted that this research does not consider the support available from existing policy mechanisms, which would naturally be available to aid homeowners and landlords.

In an attempt to provide some insight into the extent to which Irish landlords have the financial capacity to invest in energy efficiency upgrades, we deploy some simple hypothetical investment scenarios and explore the number of households that could undertake these investments, based on their individual level of wealth and resources as outlined in the HFCS survey.

These scenarios are developed to be hypothetical in nature but to reflect the range of investments that could be needed for more straightforward investments, such as attic insulation, and installation for heat pumps towards more complete retrofits. For simplicity, we use four potential investment expenditures of €25k, €50k, €75k and €100k, and simulate how many household landlords could afford to cover these expenditures using their financial assets or deposits in the HFCS micro data.

In each of the hypothetical scenarios, we determine a financial gap, which is the difference between the level of the investment and the level of resources that the household has at their disposal:

> Investment gap = The hypothetical investment level – Total household financial wealth (or deposits)

Some households will have sufficient resources to cover the expenditure; therefore, they will not have a gap per se, i.e. the above indicator will be negative. We can therefore define an indicator variable that takes the value of 1 if a household has insufficient resources to cover the expenditure and is 0 otherwise: the investment gap for each J investment value for each household h as follows:

$$I(GAP)^{*}{}_{j,h} = \begin{cases} I^{*} & if \quad I(GAP)_j > 0 \\ 0 & if \quad I(GAP)_j \leq 0 \end{cases}$$

where:

$$I(GAP)_j = J - F_h$$

J takes the values of each of the above investments and F_h is the measure of household h financial wealth used in the scenario. We will therefore report two outcomes from this analysis in our reporting:

- share of households with an investment gap (% of landlords); and
- the median level of the gap for each household with a gap.

Typically, investment is financed by liquid funds or savings held in accounts (if own funds are being used). Therefore, we use two different measures of financial assets in this analysis. First, we use total financial assets, as defined in Section 5.1. However, we also use total deposits as a more realistic indicator of financial resources available to invest, as some landlords may hold other financial assets in longer term, more illiquid holdings, which they may not be able to access (such as pension funds). We present findings for the four hypothetical investment levels as well as the two different measures of financial wealth.

Table 5.7 presents the proportion of landlords who are experiencing an investment gap, i.e. the proportion of landlords who are unable to cover the investment expenditures using their financial wealth. The four investment simulations are presented in each row of the table, while the two different measures of the financial resources are presented in the columns. As deposits are included in financial wealth, the strictest scenario in terms of difficulty to achieve for landlords is the high investment (€100k) financed by deposits.

TABLE 5.7 PROPORTION OF LANDLORDS UNABLE TO FINANCE THE INVESTMENT ACTIVITY BY FINANCIAL MEASURE AND INVESTMENT SIZE

Simulated investment requirement	F = Financial wealth	F = Deposits
J=€25k	49%	49%
J=€50k	62%	70%
J=€75k	71%	81%
J=€100k	77%	86%

Source: Analysis based on CSO HFCS data.

The results for the proportion of landlords unable to cover the indicative hypothetical investment values using their financial wealth/deposits are presented in Table 5.7. In total, just under half of Irish landlords would have insufficient savings to afford a €25k investment using either their total financial wealth or their savings. This rises to 62 per cent (70 per cent) when considering the use of financial wealth (deposits) to cover the €50k investment. Considering the largest hypothetical investment of €100k, 23 per cent of landlords would have sufficient overall financial wealth to cover the expenditure required for this level of investment, while 14 per cent of landlords would have sufficient deposits to cover this expenditure. These figures point to quite a complex picture in terms of the investment capacity of landlords. Nearly half of landlords are unable to cover the smallest investment level considered, of €25k, pointing to a notable absence of investment capital and a low liquid wealth concentration for most landlords. As these landlords are unlikely to be willing to invest all of their funds on energy efficiency, activating retrofits on their properties is going to be challenging without supports. On the other hand, between one-in-five and one-in-seven have sufficient wealth to cover large investments of €100k, depending on whether total financial wealth or deposits are included.

To understand more about the investment gap faced by those landlords with insufficient funds, Table 5.8 presents the median investment gap for those landlords, i.e the gap between their own financial assets/deposits and the hypothetical investments. Again, the information is presented in terms of median levels to provide information on the typical gap.

TABLE 5.8 MEDIAN INVESTMENT GAP OF LANDLORDS UNABLE TO FINANCE THE INVESTMENT ACTIVITY BY FINANCIAL MEASURE AND INVESTMENT SIZE

Simulated investment requirement	F = Financial wealth	F = Deposits
J=€25k	13,966	14,161
J=€50k	32,130	32,384
J=€75k	51,067	51,067
J=€100k	71,197	73,266

Source: Analysis based on CSO HFCS data.

The typical gap for those landlords with insufficient funds to cover the €25k investment expenditure is approximately €14k or nearly half of the investment costs. This rises to €32k for the €50k investment, and €50k for the €75k investment using both measures. The typical gap for those landlords with insufficient funds to cover the €100k investment is €73k.

5.2.1 Cost of financing

The final element in this section explores the cost implications for landlords if they were to borrow the financing for the investment gap. To do this, we undertake the following simulation. For each landlord who has a financing gap as defined above, we simulate the cost of the overall investment gap, in terms of the monthly repayments if the loan were to be financed using a personal loan. We use an interest rate of 6.5 per cent over a 10-year term to simulate the repayment amount[16] as follows:

$$\text{Month Repay} = IGAP\ \times \left(\frac{r(r+1)^n}{(1+r)^n - 1}\right)$$

The repayment amounts are presented in Table 5.9 below. Focusing on the deposits measure of wealth (which is closer to available funds), if landlords were to borrow using the loan terms presented above, the typical repayment per month would be €921 to cover the investment gap for the €25k investment expenditure. This rises notably for the €50k investment, for which the repayment would rise to over €2,100 per month. The levels are much higher for the €75k and €100k investments, at €3,321 and €4,765 per month respectively. For these extremely high investment levels, it is unlikely that this particular product would be used to fund the larger expenditures; lower rate products with longer terms would be needed to ensure affordability and also viability. Indeed, landlords who are undertaking larger retrofits that fall into the criteria of the One Stop Shop (OSS) from the SEAI can avail of a low-cost finance option backed by the Strategic Banking Corporation of Ireland (SBCI). The Home Energy Upgrade Loan Scheme is a new low-cost financing option that could be availed of. It does not however include solar panels as a separate option and would not cover smaller upgrades that would fall outside the scope of the OSS process. For this reason, it would not be available for all landlords for all upgrades. Our results therefore can be seen as a worst-case cost option (or an upper bound) for landlords, if they were to finance their activities at market rates. Moreoever, it does not include existing grant supports, which would also offset the costs.

TABLE 5.9 MEDIAN MONTHLY REPAYMENT AMOUNT OF LANDLORDS WHO REQUIRE A LOAN TO COVER THE INVESTMENT GAP

Simulated investment requirement	F = Financial wealth	F = Deposits
J=€25k	908	921
J=€50k	2,090	2,106
J=€75k	3,285	3,321
J=€100k	4,630	4,765

Source: Analysis based on CSO HFCS data.

It must be noted that it is not necessarily the case that a personal loan at this particular interest rate would be the desired financing mechanism for these landlords. Other mechanisms could include a mortgage top up or equity release. This may be particularly the case for the larger investment activities. However, it is

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[16] On 17 November 2022, both Allied Irish Bank and Bank of Ireland had a green personal loan or a green home improvement loan of 6.4 and 6.5 per cent respectively. These are used as indicative market interest rates for a similar activity.

not clear that this would be possible for those landlords who do not have an outstanding mortgage, or for those who are either retired or not economically active, as they would not be able to borrow commercial mortgages. However, if the interest rate was to converge to the mortgage rate (rather than the personal rate loan used above) and the term was to remain as is, this would lower the repayment burden.

5.2.2 Access to investment finance

In this sub-section, we test the financial burden on potential landlords if the investment was to be financed. If landlords were to turn to commercial finance, then they would need to demonstrate a sufficient repayment capacity on the new borrowings, and their existing debts, to be able to finance these investments. A key metric that any commercial institution will use to screen borrowers is the affordability of the repayments relative to the income of the borrower. To explore the affordability to each borrower of the repayments simulated in the previous section, we calculate debt–service ratios (DSR) for each landlord for those with outstanding debts, and sequentially add on the simulated repayments for each of the investment scenarios. The DSR is defined as follows:

$$\mathrm{DSR}_h = \left(\frac{\text{Monthly repayments}}{\text{Monthly disposable income}}\right)$$

The DSR has been shown in research to be a good predictor of ex-post loan arrears (Gerardi et al., 2018; Slaymaker and O'Toole, 2021), and is used in commercial underwriting processes. For each household, we simulate the change in the DSR under each scenario as follows:

$$\mathrm{DSR\ shock\ (J)}_h = \left(\frac{\text{Monthly repayments} + S\text{imulated payment}}{\text{Monthly disposable income}}\right)$$

This provides us with a scenario-specific level of debt service for the new and existing loan balances for each landlord household. A further indicator that we use is the proportion of households whose debt burden is greater than 30 per cent. This indicator is used in housing research as a typical financial distress measure; above this point the likelihood of households facing housing payment stress rises (Corrigan et al., 2019).

$$\text{High debt burden} = \text{Proportion of households with DSR} > 30\%$$

Table 5.10 presents the DSR and the proportion of households with a DSR above 30 per cent. In the baseline, the median DSR for households was 19 per cent, with one-in-three being classed as having a high debt burden. This rises to a median repayment of 34 per cent for the €25k investment and 57 per cent or nearly one-in-every two landlords being classed as having a high debt burden in terms of repayments to income. The larger investment requirements have commensurately larger debt impacts.

TABLE 5.10 DSR FOR LANDLORDS WITH EXISTING DEBT AND REPAYMENTS AS PER INVESTMENT GAPS

Simulated investment requirement	Debt-service-to-income ratio	Proportion of households with DSR > 30 %
Baseline	19%	30%
J=€25k	34%	57%
J=€50k	49%	75%
J=€75k	66%	85%
J=€100k	83%	91%

Source: Analysis based on CSO HFCS data.

Repayment capacity is only one aspect of the affordability assessment; another is the ability to have sufficient collateral. To explore this, we take the above proposed investment gaps as additional borrowings and add them to the existing loans of each landlord to simulate a scenario loan-to-value ratio. The simulations are available in Table 5.11. The median loan-to-value ratio for the group was just over 26 per cent before the borrowing; this rises only marginally to 28 per cent. These households therefore do have the collateral, if not the repayment capacity, to leverage these hypothetical loans.

TABLE 5.11 LOAN-TO-VALUE RATIO (PORTFOLIO LEVEL) FOR LANDLORDS WITH EXISTING DEBT AND BORROWING ABOVE LOAN AMOUNTS

Simulated investment requirement	Loan-to-value ratio
Baseline	26.2%
J=€25k	28.5%

Source: Analysis based on CSO HFCS data.

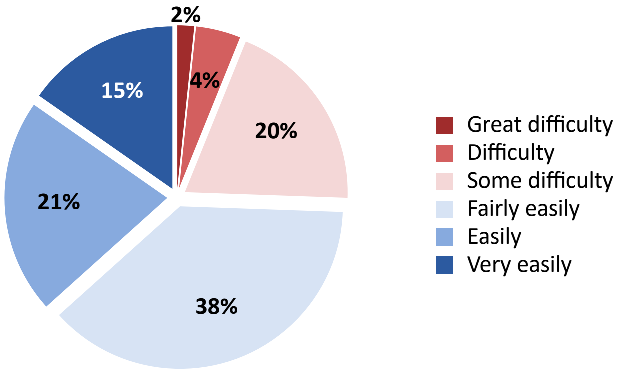
5.2.3 Investment appetite and financial circumstances

In addition to the above metrics on the DSR and the loan-to-value ratio, there are numerous other reasons why landlords may not be able to access sufficient finance to undertake the borrowing required to meet the investment gaps. As has been noted previously in this research, many landlords are not particularly wealthy (in terms of liquid wealth) and often have a single rented property. They can therefore face considerable financial challenges in their own households' circumstances that would lead them to either a) be unable or unwilling to commit further capital to the investment property, or b) be unable to gain additional financing from a financial institution.

To gain some insight into the credit worthiness and financial position of landlords, we use a number of different indicators from the EU Survey of Income and Living Conditions (SILC) and HFCS datasets. We introduce the EU SILC database here for the first time. Please note that this dataset uses a slightly different definition of landlords compared to that used in the HFCS.

First, Figure 5.8 presents responses to the question, 'Do you have difficulty making ends meet?'. While the majority of landlords do not indicate considerable problems with general financial distress, there is a cohort (approximately one-in-four) of landlords who do indicate at least some difficulty in makings ends meet.

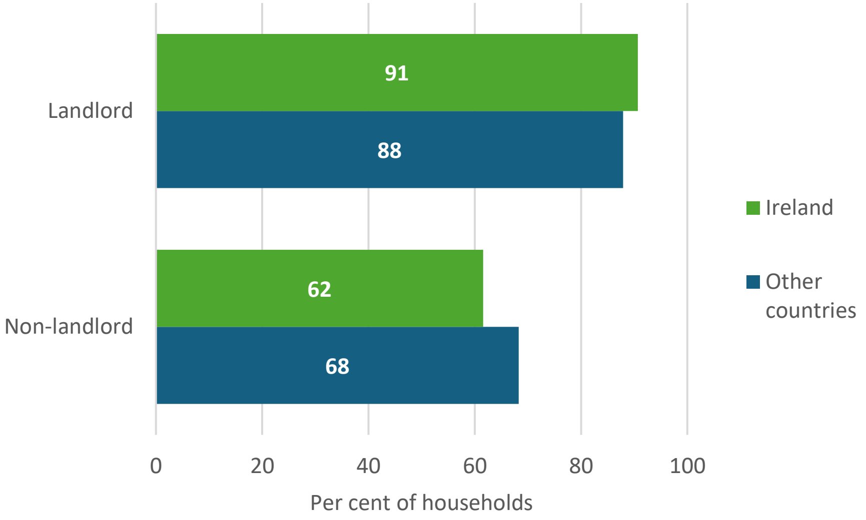
FIGURE 5.8 DIFFICULTY MAKING ENDS MEET



Source: Analysis based on EU SILC data.

Another indicator of distress that is useful in the context of general financial capacity is the ability to meet an unexpected expense. Figure 5.9 below presents the share of landlords and non-landlords that indicate they could meet an unexpected expense in Ireland, and on average across a group of comparator countries in the EU SILC. It is clear that while a majority of landlords in Ireland (nine-in-ten) do have sufficient resources to meet an unexpected expense, there is a cohort of those who cannot do so. It is also notable that the share of landlords who have the means to deal with an unexpected expense is higher in Ireland than that found among other European landlords. It is also much higher as compared with non-landlords, whose financial position is considerably weaker.

FIGURE 5.9 ABILITY TO COVER AN UNEXPECTED EXPENSE – % OF HOUSEHOLDS WHO COULD AFFORD TO DO SO

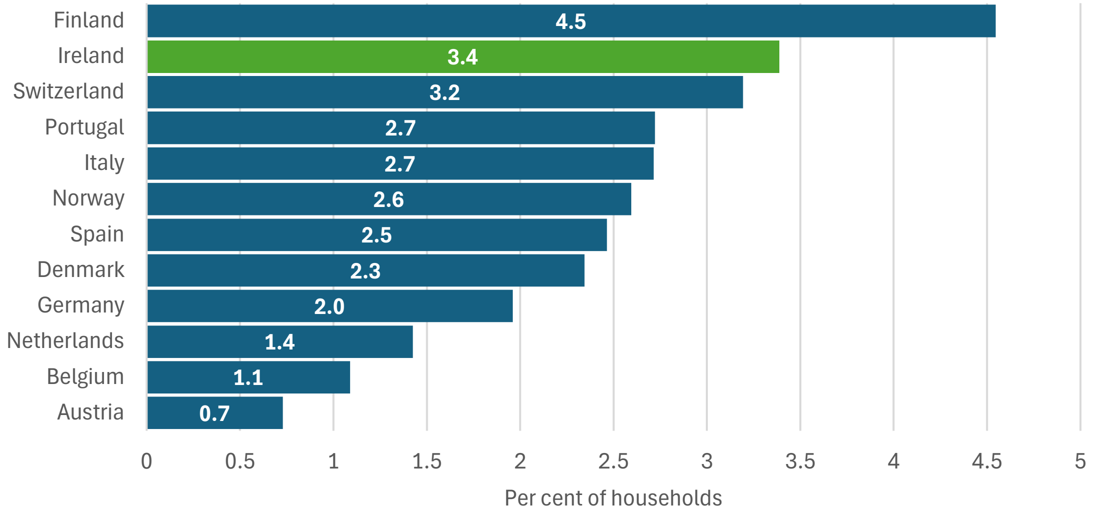


Source: Analysis based on EU SILC data.

A stricter, and less perception-based, indicator of financial distress is that of missed payments on loans or utility bills. Figure 5.10 below presents data on the extent to which landlords have missed payments on either mortgage loans, other personal loans, or utilities in the past 12 months. Ireland is presented, along with some other countries to provide context. It is clear that the level of arrears is low for Irish and other landlords in absolute terms. While Ireland is the second highest of the countries presented, the share of landlords in arrears here is less than 3.5 per cent in total. This degree of missed payments would not necessarily indicate a particularly stressed household grouping based on this measure.

Coupling the charts on financial capacity, and the analysis of access to credit, it is noteworthy that while the financial position of landlords is healthy in the main, there are certainly pockets of landlords who are in a financially challenged position. These households are unlikely to be in a position to commit additional capital in terms of undertaking energy efficiency investments, even if there were investments they would like to undertake. However, a more pressing constraint may be the age grouping of landlords; older, retired landlords are highly unlikely to receive commercial finance and, therefore, to be in a position to borrow to invest.

FIGURE 5.10 PER CENT OF LANDLORDS IN SOME PAYMENT ARREARS – IRELAND VS OTHER COUNTRIES 2019



Source: Analysis based on EU SILC data.
Note: Payment arrears relate to payments on mortgages/rent, utilities and other loans.

5.2.4 Investment appetite

All of the discussion to this point in Chapter 5 has assumed that landlords have financial resources that they are willing to commit to investment activities in their buy-to-let portfolio. The financial capacity assessment and access to credit analysis also assumes that landlords are willing to make the investment changes. However, the research in Chapter 2 highlights that landlords face considerable split incentives in terms of their willingness to invest in these properties; i.e. they are not going to be the recipients of higher returns or lower costs of running the property if for example utility bills fall for the renting tenants. Furthermore, many of these landlords are retired households, in the lifecycle phase of running down economic wealth to cover retirement living costs.

These factors combined may indicate a low potential appetite for investment among landlords, from an economic perspective; this is alongside the difficulties in terms of financing or hardship indicated above. There is also the likelihood that these households are going to face investment costs on their own main residence from an energy efficiency context as well. For example, they may wish to invest in their own residence to buffer against rising utility bills before they commit capital to rental properties. While it is difficult to obtain data to explore this hypothesis, the SILC survey can be used to identify those landlords whose own property has issues with poor light or darkness or also suffers from damp, rot or a leaking roof. The data are presented in Figure 5.11 below for landlords, non-landlords across Ireland and other countries. Approximately 9 per cent of Irish landlords have damp in their own properties, a rate that is lower than found among non-landlords in Ireland and abroad. Additionally, approximately 9 per cent of landlord households also have dark/light issues in their domestic dwelling. Both of these indicators point to some problems with the housing stock of landlords' personal dwellings.

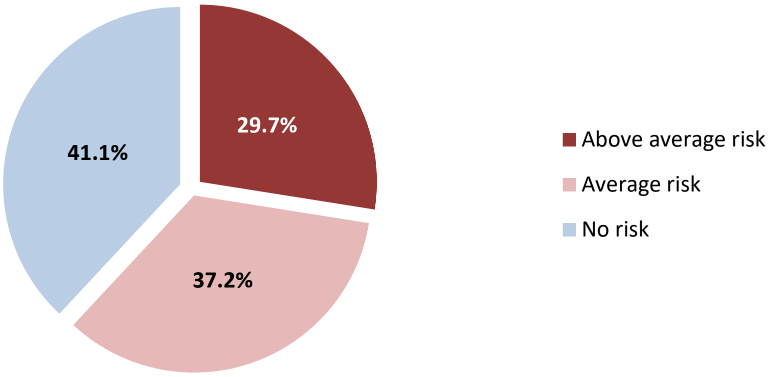
However, these indicators are unlikely to capture the full extent of landlords with investment requirements in their own household.

FIGURE 5.11 PERCENTAGE OF HOUSEHOLDS INDICATING A PROBLEM IN THEIR DWELLING

Source: Analysis based on EU SILC data.

To gain further insights into the risk appetite for investment among landlords, we can draw on the HFCS data. An indicator in the survey comes in the question that asks households to identify their willingness to take risks to earn rewards. This indicator is useful in that it may provide a proxy for landlords' willingness to engage in energy efficiency expenditures with an uncertain return. Households are asked to indicate whether they are willing to take above-average risk to earn above-average return, average risk to earn average return or no risk at all. This is a good indicator of investment appetite. We present the data below in Figure 5.12 for those landlords who are identified as having an investment gap in the €25k scenario. Approximately 41 per cent indicate they would be unwilling to take any risk, a further 37 per cent would take average risk and only 29 per cent would take above-average risk. This suggests quite a risk averse group of households.

FIGURE 5.12 PROPORTION OF LANDLORDS WITH AN INVESTMENT GAP BY THEIR WILLINGNESS TO INVEST



Source: Analysis based on CSO HFCS data.
Note: Based on a scenario with an investment requirement of €25k.

While we have raised the issue of landlord age as a potential discouraging factor in terms of investment propensity, a number of general broader factors may counteract this. From a purely financial perspective, any investment should be evaluated on a value for money basis, depending on the specific internal rate of return on the investment using discounted cash flows. This would incorporate an assessment of the investment costs, the cost of financing if required, the regulatory environment and the future rental price. As rents can be reset under the Rent Pressure Zone legislation once a major change in energy efficiency is secured, any landlord is likely to be able to re-price to recover the cost of the investment in financial terms. They can also avail of grant supports. These factors would likely offset some of the hesitancy in terms of risk appetite noted here. The impact of the perceived and actual level of compliance monitoring would also factor into their considerations. The complex interplay of all these factors is likely to determine the actual observed investment levels that will occur.

CHAPTER 6

Concluding remarks

Retrofitting the Irish private rental sector (PRS) to reduce carbon emissions will be a critical component of the overall climate transition strategy for the residential housing sector. However, there are a number of notable challenges with the rental sector that raise the complexity of meeting these targets relative to the retrofit activity of homeowners. In particular, the existence of split incentives between landlord and tenant, as well as issues regarding the capacity of the landlord sector to finance and deploy the capital investments required, are distinct challenges, which differ from those presenting in other residential market cohorts.

One starting point to measuring the scale of this challenge can be found in empirical estimates of the investment costs required to upgrade the sector, based on detailed information on the current energy efficiency status of rental properties. In this report, we aim to begin this process by achieving three main objectives. Firstly, we provide a profile of the sector in terms of its measured energy efficiency (across building energy rating (BER) categories). Secondly, we provide cost estimates (both at a property level and an aggregate level) as to what the investment cost would be to upgrade the housing stock concerned to a higher energy efficiency level. Thirdly, we explore the possible barriers to investment activity that may exist due to the high share of 'household landlords', and their potentially limited financial capacity to invest in energy efficiency upgrades.

In doing so, we draw on a number of micro-level datasets. We used the Residential Tenancies Board (RTB) register of annual tenancies and the Sustainable Energy Authority of Ireland (SEAI) BER ratings database to proxy the stock of properties in the rental sector. Alongside this, we used Local Authority Social Housing Upgrade (LASHU) data and the SEAI One Stop Shop (OSS) information to cost energy efficiency upgrades. A final source was the Household Finance and Consumption Survey (HFCS).

6.1 FINDINGS ON INVESTMENT NEEDS

Using a series of datasets (the RTB data for 2022, and SEAI data for various pooled years), we estimate that approximately 80 to 85 per cent of private rented dwellings currently have a BER rating below B; this constitutes approximately 240,000 to 260,000 properties. The vast majority of properties in this group have a D or C rating. In terms of the individual cost of upgrading properties to a B average rating, the data indicate an average cost of €43k for G-rated properties, and just under €30k per property for those currently C rated. Our estimated aggregate cost for the required upgrades in the sector ranges between €7bn and €8bn in total.

These figures suggest a substantial investment requirement in order for the sector to meet the proposed B2 ratings for properties that are rented in the private market. The achievement of this aim will be dependent on a multitude of factors, including the structure of the landlord sector (individuals versus corporations), the availability of policy supports, the regulatory environment and landlord characteristics (e.g. lifecycle stage, access to finance, investment appetite). For example, corporate landlords are more likely to be able to use economies of scale and have sufficient financial resources to upgrade properties relative to household landlords. The investment decision will however be assessed in the context of a changing sector, with uncertain return profiles given the existence of rent controls.[17] The estimates provided in this research report contribute to the emergence of a clearer picture regarding the scale of this challenge.

A number of caveats and limitations to our research must be kept in mind. First, we are working with mainly self-reported BER ratings; biases may exist in which case the actual BER distribution may differ from that outlined here. We do use the SEAI dataset as a secondary source for checking the robustness of the findings; nonetheless we cannot rule out this possibility entirely. Second, the sample of cost upgrades we use is relatively limited in terms of the number of observations and the focus on local authority activities. Again, this may lead to biases in our cost estimates. However, no other data source is available for the purposes of this study. Future research that addresses these data gaps would be welcome.

A further issue relates to our methods used to match the cost estimates with the recorded change in BER ratings. As BER ratings are very dependent on the specific properties concerned, the development of a more detailed matching system, at the property level, rather than the use of a parsimonious method with a small number of characteristics would mark a future improvement. Finally, the deployment of additional scenarios (such as to an A-rated level) would be worthy of consideration, though they would be likely to raise the cost.

6.2 FINDINGS ON THE LANDLORD STRUCTURE AND FINANCIAL CAPACITY TO INVEST

The findings of this research present a considerable challenge to the achievement of decarbonisation through investments in retrofit for the household landlord sector. International research has indicated that sub-optimal investments in energy efficiency in the rental sector occur quite frequently due to market failures and the split incentives in cost and yield on investment.

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[17] It is important to note that exemptions are in place for substantial renovations, including energy efficiency upgrades, although very few have been recorded (Coffey et al., 2022).

There are reasons to believe that these factors are likely to be present for many Irish household landlords, with considerable barriers presenting to their investing in retrofit. Many landlords do not have the financial resources to make the simulated investments we deploy in this analysis when relying on their existing financial assets. Furthermore, there are likely to be both demand and supply side factors that act to inhibit investment in retrofit in such properties. On the demand side, some landlords may face financial challenges in their general personal circumstances: one in eight landlords has less than €50k total annual income. These landlords are unlikely to be in a position to commit cash flows towards investment, especially if the return on that investment is not borne by them. Secondly, many of these households are likely to have to also consider the retrofit of their main residential dwelling, which is another call on their resources in an energy efficiency context. From the supply side, access to credit in repayment terms could be challenging for these households if commercial finance is needed to cover the financing gaps, particularly given the older age profile of these landlords, a factor that reduces any potential payback period. Rising interest rates by global central banks, as part of the snapback in monetary policy due to high inflation, is also likely to raise the cost of financing investment in energy efficiency, to present viability challenges, and to further enhance split incentive issues. Low cost loans, such as the SBCI-backed Home Energy Loan Scheme, can be impactful in terms of lowering the cost of financing investments that come under its remit.

This report focuses on filling a knowledge gap in terms of the current energy-efficiency profile of the PRS, likely upgrade costs and household landlords' financial position. Its findings suggest that policymakers face a very complex challenge in relation to encouraging these landlords to engage in energy efficiency upgrades on their rented properties.

It is beyond the study's scope to assess the numerous policies, grants and supports that are currently available, and their potential role in addressing such financing gaps, as well as any issues regarding the willingness of landlords to address the challenges identified. These are crucial topics for future research.

The focus of this report has been on the current state of play in terms of energy efficiency and landlords' financial situation, and incentives. However, the major implications of energy upgrade requirements for tenants, both in terms of likely monetary costs and tenancy security, must be kept in mind. Indeed, some of the most vulnerable tenants in the PRS live in the least energy efficient properties at present; Housing Assistance Payment (HAP) and Rent Supplement tenants have the highest share of properties with a BER rating of F or G. It is important that any policy interventions take a balanced approach to rental sector upgrades. This includes weighing up the need to make progress, but also the dangers this process might pose for tenants in particular, as it could potentially result in a reduction of the rental stock at a time where there are already significant shortages relative to demand.

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APPENDIX A

Additional results

TABLE A.1 CONCORDANCE OF DWELLING TYPES

Census 2022	RTB dataset	SEAI BER register	SEAI OSS	LASHU data
Detached house	Whole house, detached part house, detached	Detached house House	Detached house	Other
Semi- detached house	Whole house, detached part house, detached	Semi-detached house	Semi-detached/End terrace	
Terraced house	Whole house, terraced part house, terraced	Mid-terrace house End of terrace house	Mid terrace	
Flat or apartment, purpose-built flat or apartment, converted Bed-sit	Apartment Flat Maisonette, semi-det Maisonette, terraced Maisonette, detached Bed-sit	Apartment Maisonette Top-floor apartment Mid-floor apartment Ground-floor apt. Basement dwelling	Apartment	Apts

Notes: In LASHU classification, 'apts' includes apartments and mid-terrace dwellings.

TABLE A.2 MEAN ESTIMATES OF THE RENTAL HOUSING STOCK SIZE

	Estimates with accounting for BER-exempt dwellings				Estimates without accounting for BER-exempt dwellings			
	RTB		SEAI		RTB		SEAI	
BER	Est. num.	%	Est. num.	%	Est. num.	%	Est. num.	%
G	9,663	2.9	15,687	4.7	10,229	3.1	16,693	5
F	9,523	2.9	14,087	4.3	10,048	3	14,853	4.5
E2	10,239	3.1	14,897	4.5	10,808	3.3	15,732	4.8
E1	16,005	4.8	19,138	5.8	16,995	5.1	20,283	6.1
D2	31,136	9.4	36,874	11.2	32,935	10	38,930	11.8
D1	40,708	12.3	42,095	12.7	42,848	13	44,304	13.4
C3	45,029	13.6	43,022	13	47,364	14.3	45,224	13.7
C2	38,859	11.8	42,254	12.8	40,923	12.4	44,554	13.5
C1	41,306	12.5	37,019	11.2	43,725	13.2	39,277	11.9
B3	24,767	7.5	25,326	7.7	26,394	8	27,055	8.2
B2	13,054	3.9	11,678	3.5	14,068	4.3	12,573	3.8
B1	8,324	2.5	3,696	1.1	8,938	2.7	3,996	1.2
A3	8,989	2.7	4,092	1.2	9,485	2.9	4,310	1.3
A2	13,014	3.9	2,637	0.8	13,832	4.2	2,809	0.8
A1	1,922	0.6	37	0	2,040	0.6	40	0
Exempt	18,095	5.5	18,095	5.5	-	-	-	-
Total	**330,632**	**100**	**330,632**	**100**	**330,632**	**100**	**330,632**	**100**
Subtotals								
F/G	19,186	6	29,774	9	20,277	6	31,546	10
E*	26,243	8	34,035	10	27,804	8	36,015	11
D*	71,844	22	78,969	24	75,783	23	83,234	25
C*	125,195	38	122,295	37	132,011	40	129,055	39
B*	46,145	14	40,699	12	49,399	15	43,624	13
A*	23,925	7	6,765	2	25,358	8	7,159	2
Exempt	18,095	5	18,095	5	-	-	-	-
Total	**330,632**	**100**	**330,632**	**100**	**330,632**	**100**	**330,632**	**100**

TABLE A.3 NUMBER OF OBSERVATIONS IN UPGRADE COST DATA, PRE- AND POST-UPGRADE

	Building energy rating (BER) after upgrade									
BER before	C3	C2	C1	B3	B2	B1	A3	A2	A1	Total
G	0	1	0	3	11	14	31	24	4	88
F	1	0	1	2	23	25	21	9	3	85
E2	1	0	0	2	8	23	29	13	10	86
E1	0	1	0	5	9	40	54	17	4	130
D2	0	0	1	8	24	80	41	16	11	181
D1	0	0	3	4	27	89	88	15	17	243
C3		0	0	1	14	106	88	10	4	223
C2			0	1	6	92	139	32	10	280
C1				1	1	12	54	38	10	116
B3					0	1	3	13	8	25
B2						0	1	0	0	1
Total	**2**	**2**	**5**	**27**	**123**	**482**	**549**	**187**	**81**	**1,458**

Notes: Combined LASHU and SEAI OSS data.

TABLE A.4 COST OF UPGRADE ESTIMATION RESULTS

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	Dummies	With controls	Quadratic	Cubic	QReg p50	QReg p75
preBER=F	0.026	-0.009				
	(0.067)	(0.060)				
preBER=E2	-0.087	-0.056				
	(0.067)	(0.064)				
preBER=E1	-0.248***	-0.219***				
	(0.067)	(0.056)				
preBER=D2	-0.375***	-0.331***				
	(0.063)	(0.055)				
preBER=D1	-0.418***	-0.362***				
	(0.059)	(0.050)				
preBER=C3	-0.389***	-0.364***				
	(0.057)	(0.048)				
preBER=C2	-0.337***	-0.332***				
	(0.054)	(0.046)				
preBER=C1	-0.379***	-0.407***				
	(0.074)	(0.078)				
$\widecheck{\text{PreBER}}$			-1.110***	-0.555	-1.087***	-0.657***
			(0.158)	(0.364)	(0.167)	(0.209)
$\widecheck{\text{PreBER}}^2$			0.685***	-0.731	0.742***	0.248
			(0.151)	(0.879)	(0.164)	(0.205)
$\widecheck{\text{PreBER}}^3$				0.959		
				(0.591)		
Apartment dummy		-0.244***	-0.256***	-0.254***	-0.139***	-0.153***
		(0.033)	(0.032)	(0.032)	(0.028)	(0.036)
Large-size dummy		0.141*	0.132*	0.124	0.126*	0.201**
		(0.078)	(0.079)	(0.081)	(0.066)	(0.083)
Dublin dummy		0.220***	0.216***	0.214***	0.218***	0.328***
		(0.036)	(0.036)	(0.036)	(0.030)	(0.038)
Constant	10.578***	10.570***	10.658***	10.620***	10.604***	10.677***
	(0.051)	(0.043)	(0.039)	(0.042)	(0.039)	(0.049)
Observations	631	631	631	631	631	631
(Pseudo) R^2	0.179	0.280	0.268	0.271	0.129	0.201
AIC	317.2	240.2	238.6	238.4		
BIC	357.2	293.6	265.3	269.5		

Notes: Results corresponding to Table 4.2.

TABLE A.5 ESTIMATES OF AGGREGATE COSTS OF UPGRADE TO B* FOR ALL DWELLINGS WITH BER G TO C1, WITHOUT ACCOUNTING FOR HERITAGE BUILDINGS

	Cost estimation approach	RTB	SEAI
(1)	Series of dummies	7,295	8,145
(2)	Dummies + controls	7,647	8,249
(3)	Quadratic fit	7,690	8,295
(4)	Cubic fit	7,729	8,339
(5)	Quantile reg, p50	7,889	8,509
(6)	Quantile reg, p75	9,347	9,945

Notes: Results corresponding to Table 5.2.

APPENDIX B

Protected heritage buildings

Architecturally significant buildings in Ireland have restrictions on the type of renovations and alterations that can be undertaken on them, which includes limitations on types of energy efficiency upgrades. Additionally, the cost of permitted upgrades for these buildings will likely be different than the costs observed in the Local Authority Social Housing Upgrades (LASHU) data.

These buildings are also exempt from the building energy rating (BER) requirement and thus are more likely to not include a record of their BER status in the Residential Tenancies Board (RTB) data. Therefore, we want to estimate the proportion of properties within the rental housing stock that are protected listed buildings, so that they can be accounted for in the analysis. The data on protected structures comes from the National Inventory of Architectural Heritage (NIAH) database of post-1700 architectural heritage. The database does not include eircodes, but it provides latitude and longitude coordinates of every protected structure in Ireland. We match these coordinates with coordinates of all known addresses in Ireland from 2018 GeoDirectory data collected by An Post and Tailte Éireann. If an address from GeoDirectory is within 20 metres of a protected structure, the corresponding address is marked as a protected dwelling.

The NIAH database has 52,534 entries, from which we excluded all listed heritage sites that may be near, but cannot actually be, a dwelling themselves.[18] The remaining 41,515 listings are cross-referenced with 2,178,055 addresses,[19] with latitude and longitude, in the GeoDirectory.

Out of a total building stock, 77,157 eircodes (or 3.54% of the total) are identified as likely protected dwellings. Out of them 43,195 (2.53% of the total) of them are classified as residential by the GeoDirectory. Note that multiple eircodes can be assigned to the same building, such as a separate eircode for each apartment within an apartment block.

To get the final estimates of the proportion of protected rental stock, we merge GeoDirectory eircodes with RTB data. In total, 95.25% of eircodes were matched. The remaining 4.75% could be either new dwellings, newly assigned eircodes, or just incorrectly reported eircodes in the RTB data. We assume that all these non-matched observations are non-protected buildings. In total, 5.83% of the RTB sample is estimated to concern dwellings in protected buildings. Table B.1

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[18] This includes, for example, post boxes, roads, bridges, beacons, water pumps, crosses, plaques, statues, steps, telephone boxes, sundials and gates.

[19] Out of them 1,869,619 are marked as residential.

summarises the percentage of protected rental housing stock by county and dwelling type.

When these percentages are combined with Census data, we estimate that approximately 18,000 dwellings (5.5 per cent) of the rental housing stock in Ireland exists in historically protected buildings.

TABLE B.1 ESTIMATED PERCENTAGE OF HERITAGE BUILDINGS BY COUNTY AND DWELLING TYPE

County	Apartment	Detached	Semi-det.	Terraced	Total
Cork	24.5	2.2	2.4	9.5	11.9
Dublin	7.3	1.7	0.4	1.6	5
Galway	3.5	0.7	0.2	1.4	1.7
Limerick	13.5	1.1	0.8	4.3	6.3
Waterford	23.3	4	2.2	22.2	14.1
Other	9.3	1.5	1	5.2	4.1
Total	**9.7**	**1.6**	**1**	**4.7**	**5.5**

Source: Estimates based on NIAH database, 2018 GeoDirectory data and RTB tenancy registrations data.

APPENDIX C

Regression results for missing RTB BER ratings

TABLE C.1 CHARACTERISTICS OF PROPERTIES WITH BER COMPARED TO WITHOUT BER

	(1)	(2)
Variable	Logit coefficient	Marginal effects
Floor area	-0.000	-0.000
	(0.000)	(0.000)
Floor area squared	0.000***	
	(0.000)	
Monthly rent	-0.002***	-0.000***
	(0.000)	(0.000)
Monthly rent squared	0.000***	
	(0.000)	
Dwelling type: Detached	0.226***	0.055***
	(0.018)	(0.004)
Dwelling type: Semi-detached	0.084***	0.021***
	(0.012)	(0.003)
Dwelling type: Terraced	0.081***	0.020***
	(0.014)	(0.003)
Urban	0.032	0.008
	(0.022)	(0.005)
Constant	0.768***	
	(0.052)	
Observations	196,305	196,305
Pseudo R-squared	0.022	
County dummies	Yes	

Source: RTB Registrations microdata.

Notes: Floor area and monthly rent with trimmed outliers and imputed missing values. Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1

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