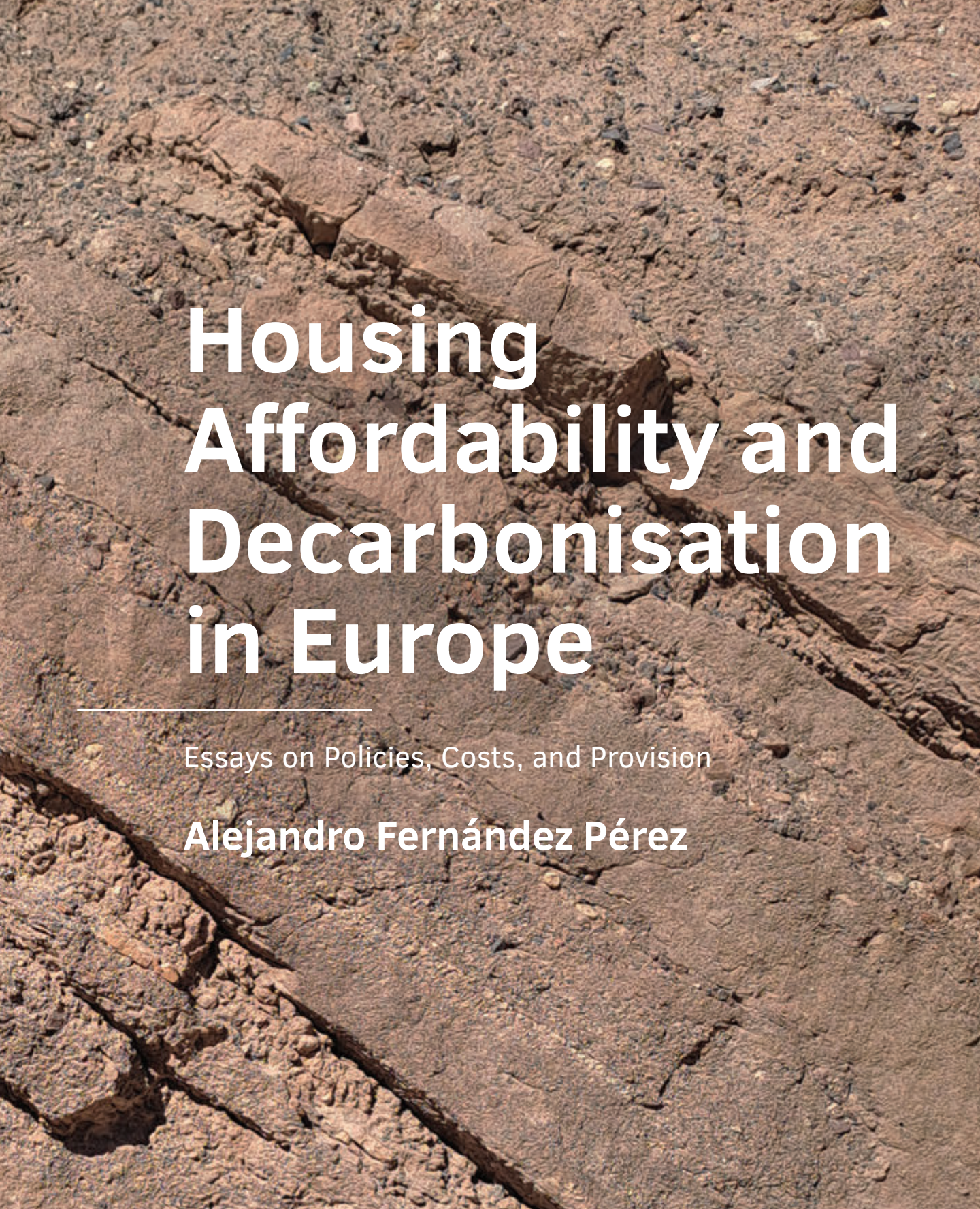

Housing Affordability and Decarbonisation in Europe

Essays on Policies, Costs, and Provision

Alejandro Fernández Pérez

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Housing Affordability and Decarbonisation in Europe

Essays on Policies, Costs, and Provision

Dissertation

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by

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Summary

This dissertation examines the interplay between housing affordability and decarbonisation against the backdrop of structural housing inequalities. Over the past century, housing has transitioned from a central locus of government intervention to an area increasingly shaped by market mechanisms, with current policies embedding sustainability further into housing provision. This thesis focuses on the impact decarbonisation policies have on affordability and provision. More specifically, the following analyses explore tensions between equity and environmental objectives highlighting the distributional implications of current approaches to the energy transition. Ultimately, this dissertation also explores alternatives to current paradigms to explicitly integrate housing redistribution within decarbonisation strategies aligning social and environmental objectives.

The specific topics of each paper have been chosen following a capita selecta approach where the point of departure was usually set by regulatory changes at the National or EU level. Alongside these regulatory aspects, fiscal policies —particularly subsidies and taxation— also have considerable influence on housing costs and provision. Together with them, informational tools, such as financial disclosure requirements and climate risk assessments, which are expected to play a relevant role in guiding private investment, become an integral component of this thesis.

Adopting a pragmatist research paradigm, this thesis employs a mixed methods approach that combines both econometric analyses and qualitative fieldwork across various European countries. Following these two methodologies, the dissertation is divided into two parts: Affordability and Costs (Part I), which quantitatively examines the economic impact of decarbonisation on households through survey and registry data; and Provision and Finance (Part II), which employs a qualitative approach to explore financing mechanisms and management decisions in housing provision. While both parts draw on different methodologies and theories, they can be read in dialogue as they explore complementary scales, household and system, and share a focus on the interlock of decarbonisation and housing provision.

Part I, encompassing chapters two, three, and four, draws on large household-level datasets and various forms of regression analysis to measure changes in housing costs. Shared across these papers is their investigation of demographic and economic factors that mediate affordability in housing decarbonisation.

Chapter two investigates the impact of housing appreciation on household consumption, a measure of living standards, over the last decade. This chapter paves the way for the rest of the thesis by highlighting the necessity of integrating housing affordability into energy transition policies to prevent exacerbating existing disparities. Drawing from the English Housing Survey (EHS) and the Living Costs and Food Survey (LCFS), a regression analysis finds heterogeneous consumption responses to house price increases. Older outright homeowners display a positive effect, increasing non-housing consumption. However, middle-aged households—predominantly renters or mortgagors— reduce their consumption compared to older ones, indicative of affordability pressures. In closing, this analysis highlights the unequal distribution of benefits associated with energy-efficient homes, with property price premiums disproportionately favouring older homeowners.

The third chapter further explores the role of tenure inequalities in the energy transition. This study employs a difference-in-differences (DiD) regression coupled with a matching procedure to evaluate the distributional impacts of housing decarbonisation on housing costs in the Netherlands. Registry data spanning 2018 to 2021 are used to construct counterfactual scenarios for decarbonised versus non-decarbonised households, enabling a robust estimation of cost impacts across tenures. The findings reveal that outright homeowners benefit from significant proportional reductions in housing costs, while mortgagors realise the greatest absolute savings due to higher baseline expenditures. Social renters experience moderate cost reductions, while private renters derive the least benefit. In the discussion, a welfare analysis incorporates the capitalisation of energy savings on property values to show how decarbonisation enhances homeowners' welfare, reinforcing existing tenure-based inequalities.

Building on the two prior explorations of tenure and age-based inequalities, chapter four highlights the potential of leveraging property taxation as a tool for more equitable housing decarbonisation, aligning environmental objectives with social equity. This fourth and final chapter in part I addresses the fiscal dimensions of housing renovation policies in the Netherlands, contrasting the distributional effects of direct subsidies with a proposed green tax linked to energy efficiency. Integrating marginal costs and benefits of renovation, derived from government and hedonic pricing data, this chapter simulates distributional impacts on the user costs of housing across income deciles. The analysis reveals that subsidies exacerbate regressive outcomes by disproportionately benefiting higher-income households. Conversely, green taxes tied to energy efficiency mitigate fiscal inequities while still incentivising renovations.

Part II, comprising chapters five, six and seven, focuses on Provision and Finance, exploring how decarbonisation and affordable housing provision initiatives are financed and managed in various countries. These essays were written during secondments with non-academic partners in Zagreb, Brussels, and Barcelona. Formulated in close collaboration with practitioners, they draw primarily from semi-structured interviews to understand the practical concerns of decision-makers involved in various forms of housing provision and management.

The fifth chapter adopts a political economy lens to examine mortgage subsidies in Croatia. This chapter builds on previous explorations of the regressive impact of demand-side policies by exploring the alignment of social policy with mortgage markets as a tool for economic growth. Drawing on policy reviews, descriptive indicators, and semi-structured interviews with stakeholders, the analysis situates mortgage subsidies within a broader strategy of financialized growth. The chapter argues that the subsidy, in inflating house prices, primarily benefits middle-income groups, thereby deepening wealth inequalities. Finally, this chapter advocates for a more comprehensive housing strategy addressing affordability across diverse income groups and tenures.

The sixth paper assesses the role of Environmental, Social, and Governance (ESG) finance in the decarbonisation of the social housing stock across five Western European countries: France, the Netherlands, Austria, Germany, and Denmark. This chapter studies the limitations of market-based mechanisms in aligning environmental and social housing objectives. Drawing on semi-structured interviews with finance directors, policymakers, and housing providers, the paper identifies three key contradictions. First, while ESG frameworks expand reporting requirements, they yield limited financial advantages, often excluding smaller providers. Second, the integration of stricter energy performance standards heightens capital expenditures, conflicting with social housing providers' mission to deliver affordable rents. Third, ESG-driven capital market restructuring creates inequalities in access to finance, privileging well-resourced providers within robust national social housing systems.

The seventh chapter investigates barriers to scaling up social rental housing provision in Spain, focusing on public-private partnerships (PPPs) as a financing model. The paper critically addresses recent policy changes that prevent the alienation of public land and aim to foster social housing delivery while lacking accompanying financial mechanisms. Through a combination of semi-structured interviews and a discounted cash flow model, the analysis identifies high borrowing costs, fiscal misalignments, and inadequate tenant protections as primary impediments to social housing delivery. Together with chapter four, this is one of the more propositional chapters as it ends by recommending the exploration of public-backed guarantees and fiscal reforms to enable sustainable social housing development within constrained public budgets.

This dissertation concludes that decarbonisation policies often favour wealthier homeowners through subsidies and consumption-based carbon taxes while having a negative or mixed impact on renters and low-income groups. At the system level, reliance on market-driven financing exacerbates affordability challenges for social housing providers, undermining their capacity to balance decarbonisation objectives with their social mission. To address these inequalities, this thesis advocates for redistributive fiscal reforms, such as energy efficiency-linked property taxes, and the strengthening of public institutions to guide investments towards equitable and sustainable housing provision. Ultimately, in integrating housing affordability within the study of decarbonisation, this dissertation aims to contribute to the formulation of decarbonisation policies which align both equity and environmental objectives.

Samenvatting

Dit proefschrift onderzoekt de wisselwerking tussen de betaalbaarheid van woningen en de decarbonisatie van de gebouwde omgeving, tegen de achtergrond van structurele ongelijkheden in de huisvestingssector. In de afgelopen eeuw is huisvesting geëvolueerd van een centraal domein van overheidsinterventie naar een steeds meer door marktmechanismen gedomineerd veld, waarbij recent beleid duurzaamheid nadrukkelijker integreert. De analyses in dit onderzoek richten zich op de effecten van decarbonisatiebeleid op zowel de betaalbaarheid als het woningaanbod, met bijzondere aandacht voor de verdelingsvraagstukken en de spanningen tussen rechtvaardigheid en ecologische prioriteiten. Ten slotte verkent dit proefschrift alternatieve benaderingen waarin een progressieve herverdeling van huisvesting expliciet wordt verweven met decarbonisatie, met als doel sociale en milieudoelstellingen beter op elkaar af te stemmen.

De onderwerpen van de afzonderlijke papers zijn geselecteerd volgens een capita selecta-benadering, waarbij de focus doorgaans wordt bepaald door wijzigingen in nationale of EU-regelgeving. Naast deze regelgevende aspecten speelt ook het fiscale beleid (met name subsidies en belastingen) een belangrijke rol, gezien de aanzienlijke impact op de kosten en het aanbod van huisvesting. Daarnaast maken informatie-instrumenten, zoals financiële rapportagevereisten en klimaatrisicobeoordelingen, een integraal onderdeel uit van de analyse, aangezien deze naar verwachting een cruciale rol zullen spelen bij het sturen van particuliere investeringen richting duurzame huisvestingsoplossingen.

Dit proefschrift volgt een pragmatistisch onderzoeksparadigma en hanteert een gemengde methodenbenadering, waarbij econometrische analyses worden gecombineerd met kwalitatief veldwerk in verschillende Europese landen. Het proefschrift bestaat uit twee hoofddelen. Deel I, Affordability and Costs (Betaalbaarheid en Kosten), onderzoekt de economische impact van decarbonisatie op huishoudens. Deel II, Provision and Finance (Voorziening en Financiering), hanteert een kwalitatieve benadering om financieringsmechanismen en managementbeslissingen binnen de woningvoorziening te analyseren. Hoewel beide delen verschillende methodologieën en theoretische kaders hanteren, staan ze in onderlinge dialoog doordat ze complementaire schaalniveaus bestuderen (namelijk huishoudens en bredere systemen) en een gezamenlijke focus hebben op de verwevenheid van decarbonisatie en huisvesting.

Deel I, dat de hoofdstukken 2, 3 en 4 omvat, analyseert veranderingen in woonlasten aan de hand van uitgebreide huishoudelijke datasets en diverse regressieanalyses. Wat deze papers verbindt, is hun focus op de demografische en economische factoren die de betaalbaarheid van woningen beïnvloeden in de context van decarbonisatie.

Hoofdstuk 2 onderzoekt de impact van de waardestijging van woningen op de consumptie van huishoudens, als indicator van de levensstandaard, gedurende de afgelopen tien jaar. Dit hoofdstuk legt de basis voor de rest van het proefschrift door te onderstrepen dat de betaalbaarheid van huisvesting een integraal onderdeel moet zijn van het energietransitiebeleid om bestaande ongelijkheden niet verder te vergroten. Aan de hand van gegevens uit de English Housing Survey (EHS) en de Living Costs and Food Survey (LCFS) voert dit hoofdstuk een regressieanalyse uit naar de uiteenlopende consumptiereacties op stijgende huizenprijzen. De resultaten tonen aan dat oudere huiseigenaren met een vast inkomen een positieve consumptiereactie vertonen, wat leidt tot een toename van de bestedingen aan niet-woongebonden goederen en diensten. Daarentegen laten huishoudens van middelbare leeftijd (voornamelijk huurders of hypotheekhouders) een beperkter consumptiepatroon zien, wat wijst op betaalbaarheidsdruk. Tot slot benadrukt de analyse de ongelijke verdeling van de voordelen van energie-efficiënte woningen: de stijgende huizenprijzen komen onevenredig ten goede aan oudere huiseigenaren, terwijl andere groepen minder profiteren van deze waardestijging.

Hoofdstuk 3 onderzoekt de rol van huurongelijkheid in de energietransitie. Deze studie hanteert een difference-in-differences (DiD)-regressie in combinatie met een matchingprocedure om de verdelingseffecten van woningdecarbonisatie op de woonlasten in Nederland te evalueren. Op basis van registergegevens uit de periode 2018–2021 worden contrafeitelijke scenario's geconstrueerd voor huishoudens met en zonder koolstofarme woningen, wat een robuuste schatting van de kosteneffecten voor alle huursectoren mogelijk maakt. De bevindingen tonen aan dat huiseigenaren aanzienlijke proportionele verlagingen van hun woonlasten ervaren, terwijl hypotheekhouders de grootste absolute besparingen realiseren vanwege hun hogere initiële uitgaven. Sociale huurders profiteren van gematigde kostenreducties, terwijl particuliere huurders het minst voordeel behalen. In de discussie wordt via een welvaartsanalyse de kapitalisatie van energiebesparingen in de vastgoedwaarde onderzocht, waarmee wordt aangetoond hoe decarbonisatie de vermogenspositie van huiseigenaren versterkt en bestaande ongelijkheden in de huurmarkt vergroot.

Voortbouwend op de eerdere analyses van huur- en leeftijdsgerelateerde ongelijkheden, onderzoekt hoofdstuk 4 het potentieel van vermogensbelasting als instrument voor een rechtvaardigere decarbonisatie van de woningmarkt. Dit hoofdstuk beziet duurzaamheid in samenhang met sociale rechtvaardigheid door de fiscale aspecten van het Nederlandse woningrenovatiebeleid te analyseren. Daarbij worden de verdelingseffecten van directe subsidies afgezet tegen een voorgestelde groene belasting gekoppeld aan energie-efficiëntie. Op basis van overheidsgegevens en hedonische prijsmodellen simuleert dit hoofdstuk de impact van deze beleidsmaatregelen op de gebruikerskosten van huisvesting over verschillende inkomensdecielen. De analyse toont aan dat subsidies de ongelijkheid vergroten, aangezien zij onevenredig ten goede komen aan huishoudens met hogere inkomens.

Groene belastingen op basis van energie-efficiëntie daarentegen verminderen fiscale ongelijkheid, terwijl ze tegelijkertijd renovaties stimuleren.

Deel II, bestaande uit de hoofdstukken 5, 6 en 7, richt zich op voorzieningen en financiering en onderzoekt hoe initiatieven voor koolstofvrij women en aanbod van woningen in verschillende landen worden gefinancierd en beheerd. Deze essays zijn geschreven tijdens detacheringen bij niet-academische partners in Zagreb, Brussel en Barcelona en tot stand gekomen in nauwe samenwerking met professionals uit het veld. De analyses zijn grotendeels gebaseerd op semi-gestructureerde interviews, waarmee inzicht is verkregen in de praktische overwegingen van beleidsmakers die betrokken zijn bij diverse vormen van woningvoorziening en -beheer.

In hoofdstuk 5 wordt de rol van hypotheeksubsidies in Kroatië onderzocht vanuit een politieke-economische benadering. Dit hoofdstuk bouwt voort op eerdere studies naar het regressieve effect van vraagzijdebeleid door het sociaal beleid met de hypotheekmarkten af te stemmen als instrument voor economische groei. De analyse, die gebaseerd is op beleidsevaluaties, beschrijvende indicatoren en semigestructureerde interviews met relevante stakeholders, plaatst de hypotheeksubsidies binnen een breder kader van financiële groei. Het hoofdstuk concludeert dat de subsidie, door de huizenprijzen te verhogen, voornamelijk ten goede komt aan middeninkomensgroepen, waardoor de welvaartsongelijkheid toeneemt. Tot slot pleit het hoofdstuk voor een meer geïntegreerde huisvestingsstrategie die zich richt op de betaalbaarheid voor verschillende inkomensgroepen en huurperioden.

Hoofdstuk 6 onderzoekt de rol van ESG-financiering (Environmental, Social, and Governance) bij de verduurzaming van de sociale woningvoorraad in vijf West-Europese landen: Frankrijk, Nederland, Oostenrijk, Duitsland en Denemarken. Dit hoofdstuk benadrukt de beperkingen van marktgebaseerde mechanismen bij het afstemmen van duurzaamheid en sociale huisvestingsdoelen. Op basis van semigestructureerde interviews met financieel directeuren, beleidsmakers en woningcorporaties worden drie belangrijke tegenstrijdigheden geïdentificeerd. Ten eerste, hoewel ESG-raamwerken de rapportagevereisten uitbreiden, leveren ze slechts beperkte financiële voordelen op, waardoor kleinere aanbieders vaak worden uitgesloten. Ten tweede, de integratie van strengere energieprestatienormen verhoogt de kapitaaluitgaven, wat in conflict is met de missie van sociale huisvesters om betaalbare huren te bieden. Ten derde, de herstructurering van de kapitaalmarkt op basis van ESG creëert ongelijkheden in de toegang tot financiering, waardoor goed gefinancierde aanbieders binnen robuuste nationale sociale huisvestingssystemen worden bevoordeeld.

Hoofdstuk 7 onderzoekt de belemmeringen voor de productie van van sociale huurwoningen in Spanje, met bijzondere aandacht voor publiek-private partnerschappen (PPP's) als financieringsmodel. De paper biedt een kritische analyse van recente beleidswijzigingen die gericht zijn op het voorkomen van de vervreemding van openbare grond en het bevorderen van sociale woningbouw, terwijl de noodzakelijke financiële mechanismen ontbreken. Door middel van een combinatie van semi-gestructureerde interviews en een discounted cash flow-model worden

hoge financieringskosten, fiscale onevenwichtigheden en inadequate huurderbescherming geïdentificeerd als de belangrijkste obstakels voor sociale woningbouw. In combinatie met hoofdstuk 4 vormt dit een van de meer propositionele hoofdstukken, omdat het eindigt met concrete aanbeveling voor het onderzoeken van door de overheid gesteunde garanties en fiscale hervormingen die de ontwikkeling van duurzame sociale woningbouw mogelijk kunnen maken, binnen de grenzen van beperkte overheidsbudgetten.

Dit proefschrift concludeert dat verduurzaming vaak gunstig is voor rijkere huiseigenaren, met name via subsidies en consumptiegebaseerde koolstofbelastingen, terwijl het negatieve of gemengde effecten heeft op huurders en lage inkomensgroepen. Op systeemniveau verergert de afhankelijkheid van marktgestuurde financiering de betaalbaarheidsproblemen voor aanbieders van sociale huisvesting, wat hun vermogen om een balans te vinden tussen decarbonisatie en hun sociale missie ondermijnt. Om deze ongelijkheden te verminderen, pleit dit proefschrift voor herverdelende fiscale hervormingen, zoals vermogens die gekoppeld zijn aan energie-efficiëntie, en voor de versterking van publieke instellingen die investeringen kunnen sturen richting rechtvaardige en duurzame huisvesting. Door de betaalbaarheid van huisvesting te integreren in het onderzoek naar decarbonisatie, beoogt dit proefschrift een bijdrage te leveren aan de ontwikkeling van progressief decarbonisatiebeleid dat sociale en milieudoelen met elkaar verbindt.

Resumen

Esta disertación examina la interacción entre la asequibilidad de la vivienda y la descarbonización en el contexto actual, marcado por desigualdades estructurales en el acceso a la vivienda. Durante el último siglo, la vivienda ha pasado de ser un eje central de la intervención gubernamental a un ámbito cada vez más moldeado por mecanismos de mercado. Recientemente, la política pública ha tendido a hacer de la sostenibilidad un elemento cada vez más central en la provisión de vivienda. Esta tesis desarrolla una serie de análisis acerca del impacto de las políticas de descarbonización y provisión en la asequibilidad de la vivienda, destacando sus implicaciones distributivas así como las tensiones existentes entre la equidad y los objetivos medioambientales. Finalmente, esta disertación presenta también enfoques alternativos que alinean objetivos sociales y ambientales a través de la integración explícita de la redistribución en las políticas de provisión y descarbonización.

Los temas específicos de cada capítulo han sido seleccionados siguiendo un enfoque de "capita selecta," donde el punto de partida suele estar marcado por cambios regulatorios a nivel nacional o de la Unión Europea. Además de estos aspectos regulatorios, las políticas fiscales—particularmente subsidios e impuestos—también cobran protagonismo debido a su considerable influencia en los costos y la provisión de vivienda. Junto a ellos, herramientas informativas como los requisitos de divulgación de información financiera y las evaluaciones de riesgos climáticos, que se espera jueguen un papel relevante en la dirección de la inversión privada hacia soluciones habitacionales sostenibles, son también un componente integral de este análisis.

Adoptando un paradigma de investigación pragmático, esta tesis emplea un enfoque de métodos mixtos que combina análisis econométricos y trabajo de campo cualitativo en varios países europeos. La disertación se divide en dos partes principales: Asequibilidad y Costos (Parte I), que examina el impacto económico de la descarbonización en los hogares; y Provisión y Financiamiento (Parte II), que utiliza un enfoque cualitativo para explorar los mecanismos de financiamiento y las decisiones de gestión en la provisión de vivienda. Aunque ambas partes recurren a metodologías y teorías diferentes, pueden leerse en diálogo, ya que exploran escalas complementarias—la del hogar y la del sistema—y comparten un enfoque temático centrado en la intersección entre descarbonización y provisión de vivienda.

La Parte I, que comprende los capítulos dos, tres y cuatro, utiliza grandes conjuntos de datos a nivel de hogar y varios tipos de análisis de regresión para medir los

cambios en los costos de la vivienda. Un hilo conductor en estos capítulos es la investigación de los factores demográficos y económicos que median la asequibilidad en la descarbonización de la vivienda.

El capítulo dos investiga el impacto de la revalorización de las viviendas en el consumo de los hogares, una medida de los estándares de vida, durante la última década. Este capítulo sienta las bases del resto de la tesis al destacar la necesidad de integrar la asequibilidad de la vivienda en las políticas de transición energética para evitar la exacerbación de las desigualdades existentes. Utilizando la English Housing Survey (EHS) y la Living Costs and Food Survey (LCFS), un análisis de regresión encuentra respuestas heterogéneas en el consumo frente al aumento de los precios de la vivienda. Los propietarios mayores sin hipoteca muestran un efecto positivo, aumentando su consumo no relacionado con la vivienda, mientras que los hogares de mediana edad—predominantemente arrendatarios o hipotecados—exhiben patrones de consumo restringidos, indicativos de presiones de asequibilidad. Este análisis concluye destacando la distribución desigual de los beneficios asociados a las viviendas energéticamente eficientes, con primas de precio de las propiedades que favorecen desproporcionadamente a los propietarios de mayor dead.

El tercer capítulo profundiza en el papel de las desigualdades de tenencia en la transición energética. Este estudio emplea un análisis de diferencias en diferencias (DiD) combinado con un procedimiento de emparejamiento para evaluar los impactos distributivos de la descarbonización en los costos de la vivienda en los Países Bajos. Utilizando datos de registro de 2018 a 2021, se construyen escenarios contrafactuales para hogares descarbonizados frente a no descarbonizados, lo que permite una estimación robusta de los impactos en los costos según la tenencia. Los resultados revelan que los propietarios sin hipoteca obtienen reducciones proporcionales significativas en los costos de vivienda, mientras que los hipotecados logran los mayores ahorros absolutos debido a mayores gastos base. Los arrendatarios sociales experimentan reducciones moderadas en los costos, mientras que los arrendatarios privados derivan el menor beneficio. La discusión incorpora un análisis de bienestar que incluye la capitalización de los ahorros energéticos en los valores de propiedad, mostrando cómo la descarbonización mejora el bienestar de los propietarios, reforzando las desigualdades existentes basadas en el régimen de tenencia.

El capítulo cuatro resalta el potencial la política fiscal para una descarbonización de la vivienda más equitativa, alineando los objetivos ambientales con la equidad social. Este capítulo aborda las dimensiones fiscales de las políticas de renovación en los Países Bajos, contrastando los efectos distributivos de los subsidios directos con una propuesta de impuesto verde vinculado a la eficiencia energética. Tras integrar costos y beneficios marginales de las renovaciones, derivados de datos gubernamentales y precios hedónicos, este capítulo simula los impactos distributivos en los costos de uso de la vivienda a lo largo de los deciles de ingreso. El análisis revela que los subsidios exacerban los resultados regresivos al beneficiar desproporcionadamente a los hogares de mayores ingresos. Por el contrario, los impuestos verdes vinculados a la eficiencia energética mitigan las inequidades fiscales mientras siguen incentivando las renovaciones.

La Parte II, que incluye los capítulos cinco, seis y siete, se centra en la Provisión y el Financiamiento, explorando cómo se financian y gestionan las iniciativas de descarbonización y provisión de vivienda asequible en varios países. Estos ensayos han sido desarrollados durante estancias de investigación con socios no académicos en Zagreb, Bruselas y Barcelona. Formulados en estrecha colaboración con profesionales, recurren principalmente a entrevistas semiestructuradas para comprender las preocupaciones prácticas de los responsables de la toma de decisiones involucrados en diversas formas de provisión y gestión de la vivienda.

El quinto capítulo adopta una perspectiva de economía política para examinar los subsidios hipotecarios en Croacia. Este capítulo amplía exploraciones previas sobre el impacto regresivo de las políticas de demanda de vivienda. El análisis se centra en el alineamiento de las políticas sociales con los mercados hipotecarios como una herramienta para el crecimiento económico. A partir de revisiones de políticas públicas, indicadores descriptivos y entrevistas semiestructuradas con las partes interesadas, el análisis sitúa los subsidios hipotecarios dentro de una estrategia más amplia de crecimiento financializado. El capítulo argumenta que los subsidios hipotecarios, al inflar los precios de la vivienda, benefician principalmente a los grupos de ingresos medios, profundizando las desigualdades patrimoniales y privatizando la provisión de bienestar. Finalmente, este capítulo aboga por una estrategia de vivienda más integral que aborde la asequibilidad para diversos grupos de ingresos y formas de tenencia.

El sexto capítulo evalúa el papel de la financiación ESG (Ambiental, Social y de Gobernanza) en la descarbonización del parque de vivienda social en cinco países de Europa occidental: Francia, Países Bajos, Austria, Alemania y Dinamarca. Este capítulo subraya las limitaciones de los mecanismos basados en el mercado financiero para alinear los objetivos ambientales y sociales en la provisión de vivienda social. A partir de entrevistas semiestructuradas con directores financieros, responsables de políticas públicas y proveedores de vivienda, este capítulo identifica tres contradicciones clave. En primer lugar, si bien los marcos ESG amplían los requisitos de información, ofrecen ventajas financieras limitadas, a menudo excluyendo a los proveedores de vivienda más pequeños. En segundo lugar, la integración de estándares más estrictos de eficiencia energético aumenta los gastos de capital, resultando en ocasiones en un conflicto con la misión de los proveedores de vivienda social de ofrecer alquileres asequibles. En tercer lugar, la reestructuración de los mercados de capital impulsada por la legislación en materia de ESG genera desigualdades en el acceso a la financiación, privilegiando a los proveedores bien dotados de recursos dentro de sistemas nacionales robustos de vivienda social.

El séptimo capítulo investiga las barreras para aumentar la provisión de vivienda social en régimen de alquiler en España, centrándose en la colaboración público-privada como modelo de financiación. El capítulo aborda críticamente los cambios recientes en la política de vivienda social que, si bien evitan la enajenación de suelos públicos, carecen de mecanismos financieros para la construcción de vivienda social. A través de una combinación de entrevistas semiestructuradas y un modelo de flujos de caja, el análisis identifica tres factores como los principales

impedimentos para la construcción de vivienda social: los altos costos de financiamiento, la política fiscal de la construcción en alquiler y las insuficiente protección social de los inquilinos. Junto con el capítulo cuatro, este es uno de los capítulos más propositivos, ya que concluye recomendando la exploración de garantías financieras respaldadas por el sector público y la introducción de reformas fiscales para promover el desarrollo sostenible de vivienda social en un contexto marcado por las limitaciones a la emisión de deuda pública.

Esta disertación concluye que las políticas de descarbonización a menudo favorecen a los propietarios más acomodados mediante subsidios e impuestos al carbono basados en el consumo. Por el contrario, estas opciones tienen un impacto negativo o mixto en los arrendatarios y los grupos de bajos ingresos. A nivel sistémico, la dependencia de financiamiento privado exacerba los desafíos de asequibilidad para los proveedores de vivienda social, socavando su capacidad para equilibrar los objetivos de descarbonización con su misión social. Para abordar estas desigualdades, esta tesis aboga por reformas fiscales redistributivas, como impuestos sobre la propiedad vinculados a la eficiencia energética, y por el fortalecimiento de las instituciones públicas para dirigir inversiones hacia una provisión de vivienda equitativa y sostenible. En última instancia, al integrar la asequibilidad de la vivienda dentro del estudio de la descarbonización, esta disertación busca contribuir a la formulación de políticas de descarbonización progresivas que alineen los objetivos sociales y ambientales.

Housing is by far the best aid to recovery because of the large and continuing scale of potential demand; because of the wide geographical distribution of this demand; and because the sources of its finance are largely independent of the stock exchanges. [...]. In this country we partly depended for many years on direct subsidies. There are few more proper objects for such than working-class houses.

John Maynard Keynes
Letter to Franklin Delano Roosevelt of February 1, 1938

Real estate inflation is the tax one portion of society – older, more affluent homeowners and corporate landowners in coastal areas – levies on the rest of society: especially younger, less affluent families.

Mike Davies, City of Quartz, 1990

We want everyone in Europe to have a home they can light, heat, or cool without breaking the bank or breaking the planet.

Frans Timmermans, Executive Vice-President for the European Green Deal
Presentation of the Renovation Wave, 2020

1 Introduction

Affordability in Transition

1.1 Housing Transitions

European housing policy has undergone profound changes over the last century. In 1938, Keynes wrote to Roosevelt arguing that housing was a social priority that required direct government intervention. By the late 20th century, this perspective had been replaced with market-driven mechanisms as neoliberal reforms diminished the state's role in the economy. As Davies points out, this shift transformed housing into a vector of inequality driven by rising prices. Over the last decades, not only affordability but also sustainability have become central to debates about housing. As Timmermans' announcement in 2020 exemplifies, housing policy has become deeply intertwined with climate priorities, and residential decarbonisation has emerged as a cornerstone of the European Union's climate strategy.

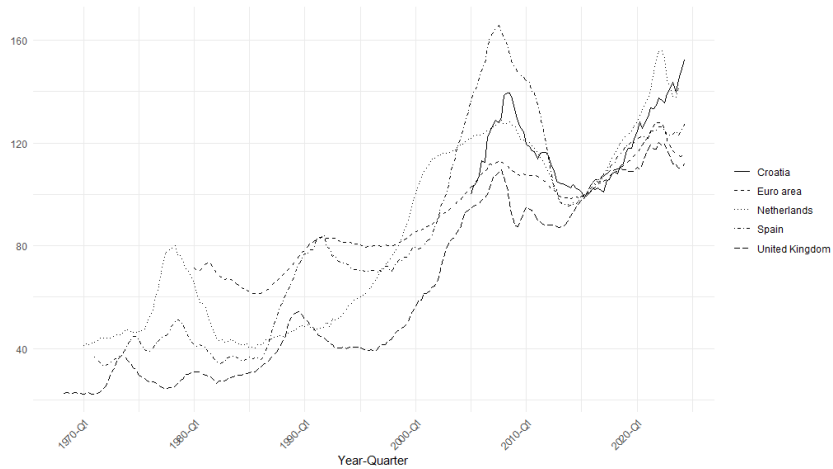
These housing transformations did not occur on a blank slate but built upon and were shaped by existing institutions. For instance, in the UK, industrialisation and the growing financial means of local authorities in the early 20th century paved the way for mass housing development post-WW2 (Power, 1993). After a period of state-led housing provision, neoliberal reforms privatised state assets shifting service provision to markets, through transfers to residents and third-party organisations (Forrest & Murie, 1988). This dissertation engages with the most recent phase in these transformations: decarbonisation. Drawing on housing literature across various disciplines, this dissertation explores how decarbonisation impacts costs and affordability, while also examining its integration into housing provision and finance.

Since Keynes' letter housing has become an increasingly contentious issue. Over the past 50 years, housing prices have soared (Figure 1), while wages, particularly over the last decade, have remained largely stagnant (Figure 2). This surge in prices has not affected all households equally. Overburdened by housing costs, a sizeable

proportion of renters now faces an increasingly precarious situation (Figure 3). In contrast, older generations of homeowners enjoy substantial capital gains, and their rate of housing costs overburden is much lower. This disparity has entrenched chronic unaffordability, especially among lower-income households (Figure 3). As Davies pointed out, housing has become a vehicle for inequitable wealth accumulation, disproportionately benefiting wealthier households who own property.

Piketty's (2014) axiom, r>g — that the rate of return on capital (r) tends to exceed the rate of economic growth (g) — is particularly relevant for housing. As Figures one and two show, returns from housing price appreciation have outstripped wage growth, enabling owners and investors to accumulate wealth much faster than those relying on income alone. While the multifaceted causes of house price appreciation are beyond the remit of this dissertation, there is widespread agreement that demand for housing outpaces a particularly inelastic supply (OECD, 2021). Grossmann et al. (2024) further illustrate that the rising housing wealth-to-income ratio has been primarily driven by increasing land values, rather than the cost of structures. Their findings emphasise that housing production's reliance on non-reproducible land, coupled with lagging technological progress in construction, has amplified land scarcity and pushed up prices.

FIG. 1.1 Quarterly Real House Prices in Spain, Croatia, The Netherlands, the Euro area and the UK by year.



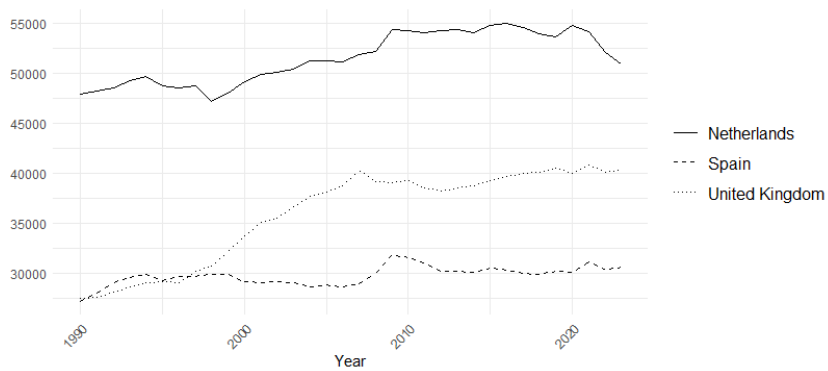
This graph shows an upward trend in average house prices and cyclical booms and busts movements. Source: OECD, 2024. Prepared by the author.

The array of policies that have contributed to mounting demand and reduced supply ranges from planning to macroprudential policies (Frayne et al., 2022). On the one hand, as private sector building plummeted in the years following the global financial crisis, social housing providers were unable to countercyclically increase supply due to the reduction or elimination of brick-and-mortar subsidies for affordable housing (Scanlon et al., 2014). On the other hand, fiscal policies—particularly the

undertaxation of housing wealth—have fuelled demand for homeownership, further driving up prices and producing clear winners and losers (Fatica & Prammer, 2018; Haffner & Heylen, 2011; Millar-Powell, 2022).

The negative welfare effects of housing undertaxation have been a central topic for economists focusing on the optimal allocation of resources, see for example Van Ewijk et al., (2007) for the Dutch case. More recently, an expanding body of research from sociology has also underscored the widening divide between homeowners and renters (Arundel & Ronald, 2021) (Arundel & Lennartz, 2019). In particular, the private rental sector has emerged as a key mechanism for wealth accumulation, largely benefiting investors from higher-income households (Hochstenbach, 2023).

FIG. 1.2 Average Real Wages in Spain, The Netherlands and the UK* by year.



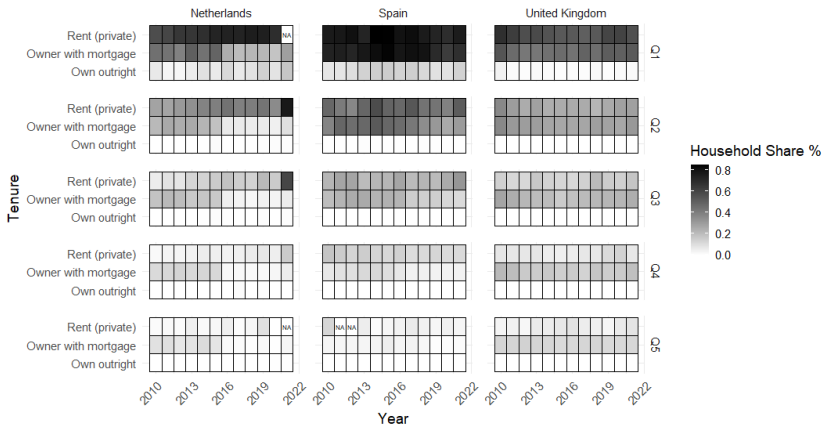
This graph shows how wages have flatlined in Spain and the Netherlands over the last 30 years, 15 years for the UK, with minor fluctuations. *Croatia is not yet in the OECD and certain indicators are unavailable. Source: OECD, 2024. Prepared by the author.

In the current unequal context, housing has undeniably emerged as a central issue on the political agenda across Europe. For instance, housing was one of the key issues voters raised running up to the recent Dutch election (Genovese, 2023). Arguably, it was also a key determinant of its results. Political scientists have in fact identified a nexus between far-right vote and rising housing inequalities in France and the UK (Adler & Ansell, 2020; Ansell & Cansunar, 2021), while in Germany, escalating rents have similarly been tied to the rise of far-right movements (Held & Patana, 2023).

Current discontent resulting from deep economic transformations bears an uncanny resemblance to the sociopolitical landscape of the 1930s. During that decade, figures like Keynes and Roosevelt reshaped the economic foundations of the West and ushered in transformative policies aimed at recovery and growth. However, the foundations on which they were operating were rife with flaws as Keynes had described in the Economic Consequences of Peace, published in 1919 following his resignation from the British delegation negotiating the Treaty of Versailles. Similarly, Europe today confronts an equally monumental challenge: transitioning to a green

economy over the foundations of decades of neoliberal reforms. This transition demands not only economic restructuring but, when it comes to the built environment, rethinking how housing is provided and managed.

FIG. 1.3 Share of households spending more than 40% of their income on housing by income quintile and tenure in Spain, The Netherlands and the UK*.



This graph shows how lower income quintiles, Q1 to Q2, are much more likely to be overburdened by housing costs, particularly among owners with a mortgage and private renters. Middle-income quintiles, Q3 to Q4, also show affordability issues that differ by country. For example, owners with a mortgage are more likely to be overburdened in the UK while it is private renters in Spain. Trends over time are more challenging to ascertain beyond chronic unaffordability for low-income renters and higher affordability for owners and higher incomes. *Croatia is not yet in the OECD and certain indicators are unavailable. Source: OECD HC1.2.A4. Total housing cost overburden rate, by income, tenure and years. Prepared by the author.

The ultimately success of Kyenes and Roosevelt resulted in the opening up a policy landscape that diverges sharply from the one available today. In the 1950s and 1960s, Western European governments played a direct role in addressing housing shortages by funding the construction of a substantial share of new housing units (Power, 1993). In contrast, today's housing policy debates lean heavily on market-based solutions. This reliance on market mechanisms marks a notable departure from the direct public interventions advocated by Keynes, such as those outlined in his letter. Moreover, contemporary housing policies are not only more dependent on market-based solutions but are also required to deliver on environmental goals.

As presented above, five years ago, the European Commission's Vice-President, Frans Timmermans, emphasised that improving housing standards to reduce energy emissions while addressing affordability had become a key objective of the European Union. These remarks were made during the launch of the Renovation Wave, Europe's strategy to improve energy efficiency in the built environment. Since the Renovation Wave, the EU's interest in housing has grown, for instance, through increased

European Investment Bank (EIB) lending for housing projects. But also, more recently with the establishment of a Commissioner for Energy and Housing who is to draft a European Affordable Housing Plan, creating an investment platform for affordable and sustainable housing. Arguably, as Europe advances toward the goal of achieving Net Zero emissions, environmental objectives have become integral to questions about housing costs and affordability.

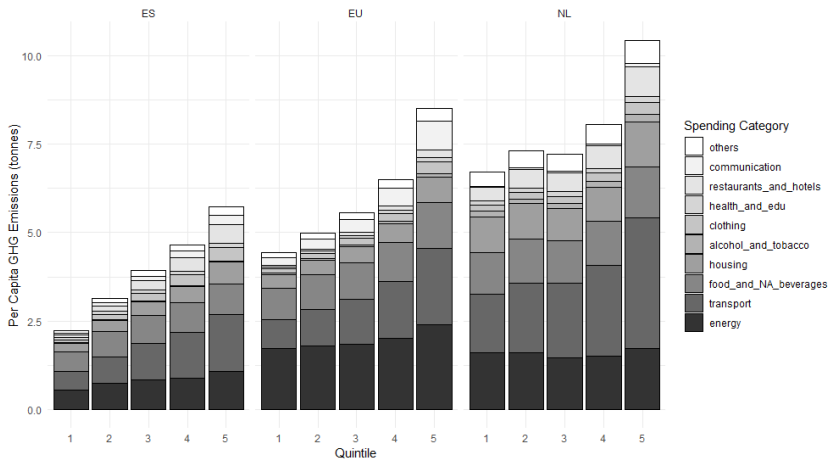
According to the Joint Research Centre (2022), residential energy consumption accounted for 28% of the European Union's final energy consumption, making it the second-largest sector after transport, which represented 28.4%. Emissions from buildings, including those resulting from direct fuel use and electricity production, were responsible for 34% of all energy-related greenhouse gas emissions in 2022 (EEA, 2024). However, despite these significant contributions to energy use and emissions, substantial progress has been made in recent decades. Decarbonisation efforts have led to a 34% reduction in emissions from buildings between 2005 and 2022 (EEA, 2024).

Decarbonisation policies enacted by European and national legislators are shaping housing markets and affordability through a variety of mechanisms (see Economidou et al., (2020), for a comprehensive classification). A notable example is the Dutch carbon pricing initiative, which seeks to curb energy consumption and promote building renovations by introducing a tax on carbon emissions. This market-based policy is however having regressive effects, disproportionately burdening lower-income households that are more likely to reside in substandard low energy efficiency housing (Maier & Ricci, 2022).

Similar proposals at EU level for the creation of a new Emissions Trading System (ETS 2) covering residential energy consumption are also expected to have regressive impacts across households (Maier et al., 2024). The taxation of carbon emissions resulting from residential energy consumption raises distributional questions since lower-income households, who tend to spend a larger portion of their resources on consumption, face a tax burden disproportionally higher than better-off ones. This effect is intensified by their higher expenditure on greenhouse gas (GHG)-intensive goods like residential energy, see Figure 4.

The distributional challenges in addressing climate change epitomise "wicked problems," where interlinked, complex dimensions resist one-size-fits-all solutions (Head, 2022). Stiglitz et al. (2023) argue that this complexity renders carbon taxation inadequate to tackle the climate crisis. They criticise the traditional climate economics framework, which views carbon pricing as the optimal solution to reducing emissions. This view assumes cost-effective reductions across homogenous emissions sources while disregarding systemic barriers and sector-specific challenges. Stiglitz et al. (2023) emphasise that decarbonisation demands transformational changes, such as large-scale infrastructure development and coordinated policies that target sector-specific hurdles, solutions a carbon tax alone cannot deliver. Their critique is particularly apposite when it comes to housing markets often riddled with inefficiencies and inelastic supply (Barr, 1998).

FIG. 1.4 Per Capita Emissions (Tonnes) by income quintile in Spain, The Netherlands and the EU.



In this graph energy refers to energy consumption while housing applies to appliances and maintenance. Emissions from energy consumption are relatively stable across income deciles, particularly for the Netherlands and the EU. This contrasts with other spending categories such as transport or clothing for which differences across quintiles are more pronounced. One of the main conclusions of Maier et al. (2024) is the potential for regressivenes in carbon taxation of residential energy consumption. Source: Maier, S., De Poli, S. and Amores, A.F., Carbon taxes on consumption: distributional implications for a just transition in the EU, European Commission, 2024, JRC138420.

In this sense, the wicked nature of climate interventions in the built environment lies precisely in its requirement for multi-dimensional, long-term interventions rather than singular, market-based instruments like carbon pricing. When examining Figures 3 and 4 together, it becomes clear that GHG emissions from residential energy consumption remain relatively constant across income quintiles while housing costs vary significantly. Hence, a transition based on consumption taxes increasing energy costs uniformly across all households will disproportionately impact lower incomes, already overburdened by housing costs. These regressive distributional impacts raise concerns about the legitimacy and public support for environmental goals, especially since housing inequalities have been linked to far-right vote by the literature referenced above.

Issues of regressiveness and inequality in the transition to net zero do not only pertain to carbon taxation and energy consumption. Narrow policy designs focused on energy-related objectives also neglect the role of housing as an asset driving wealth inequalities. For instance, a recent OECD (2024) report surveying 28 countries highlights that fiscal incentives through subsidies, such as grants and low-interest loans, are the second most common policy used to incentivise housing renovation, used in 86% of countries surveyed. These subsidies are second only to the incorporation of energy efficiency into building codes mostly targeting new buildings, implemented in 89% of countries surveyed.

The reliance on subsidies for housing decarbonisation referenced by the OECD report overlooks a critical issue, as Fatica and Prammer (2018) demonstrate, homeownership across the EU is already heavily subsidised through the undertaxation of housing wealth. This undertaxation has long been a focus of housing researchers proposing policy reforms (Pawson, 2024; Yates, 1989), and its persistence raises important questions about the justification of further subsidisation through energy renovations. Recently, the OECD has again highlighted the problematic nature of housing undertaxation, emphasising its role in perpetuating wealth inequalities (Millar-Powell, 2022). By failing to account for the regressive nature of housing undertaxation, current renovation subsidies risk reinforcing inequalities. This raises the question of whether energy efficiency-linked taxation could offer a more equitable alternative, aligning sustainability goals with affordability while addressing these existing imbalances.

Another area of focus for climate policy interventions has been financial markets, particularly through Environmental, Social, and Governance (ESG) frameworks such as the EU Taxonomy and the Sustainable Finance Disclosure Regulation (SFDR). These frameworks aim to align financial markets with environmental objectives by promoting green investments (Schoenmaker & Schramade, 2019). However, social housing provision typically operates through hybrid financing models that depend on state-backed guarantees, grants, and revolving funds (Scanlon et al., 2014; Blessing, 2012). As a result of their particular financing mechanisms, questions arise about the capacity of financial-market-driven tools to enact and adequately reward improvements in sustainability. Interrogating these frameworks requires understanding the characteristics of social housing systems and assessing the alignment between environmental goals and their core mission of providing

affordable housing.

The existence of specific frameworks for social housing finance adds to the two relevant housing-related peculiarities presented above: consumption patterns and taxation structures. These three factors shape the relationship between overarching market-driven climate policies, affordability dynamics and financing structures. This dissertation addresses this gap by analysing how decarbonisation policies influence provision and finance, as well as their effects on housing costs. It operates on the premise that housing decarbonisation policies are not confined to the energy sector, neutrally reducing utility bills and emissions. Instead, these policies intersect with pre-existing unequal housing systems and complex policy set-ups.

As decarbonisation policies play an increasingly significant role in shaping housing costs, they create distinct winners and losers across housing markets. By incorporating these dynamics into the study of housing costs, this dissertation interrogates the impact of decarbonisation on the relative position of different households across income and tenure divides. Positioned at the intersection of both climate and housing crises, this research is grounded in a housing perspective that extends outward to interrogate decarbonisation policies. As both Timmermans and Davies suggest in the quotes at the start of the chapter, housing provision simultaneously holds the potential to "break the planet" and deepen inequalities. By integrating these concerns, this dissertation aims to explore housing's potential as a vehicle for equitable growth, echoing Keynes's reflections on the role of housing in the UK in his correspondence with FDR.

In this chapter, the following section 1.2 introduces the paradigm, ethos, and scope of this dissertation. Section 1.3 defines the research problem and presents the overarching aim of the dissertation as well as the knowledge gap. The structure and subsections are explained in section 1.4. The research methods and approach are treated in section 1.5. The chapter concludes with the expected contributions from a societal and academic perspective in section 1.6.

1.2 Research Paradigm, Ethos and Scope

This subsection opens by presenting this thesis's pragmatist research paradigm, which emphasises practical problem-solving and applied policy analysis over theory-driven concerns. The subsequent section identifies the core issue addressed by this thesis—housing inequalities—and articulates the ethical foundations that could inform a progressive approach to housing within the context of the energy transition. Finally, the scope subsection deals with the selection of specific research topics.

1.2.1 A pragmatist research paradigm

In housing research, scientific paradigms diverge based on their views on rationality and their emphasis on perception or discourse. Realists assume an empirically observable world where actors make rational decisions, focusing on objective measurement and positivist inquiry. In contrast, constructivists emphasise the social construction of reality, shaped by individual experiences and meanings (Berger & Luckmann, 1966). While realism seeks to uncover objective truths through empirical inquiry, constructivism and critical realism focus on understanding the socially mediated processes that shape human experience and action. Critical realism, a third way approach, seeks to overcome these positions by acknowledging an independent reality while recognizing that our understanding is influenced by social and cultural contexts. It suggests that rationality is contextually shaped and subject to socio-political influences (Somerville & Bengtsson, 2002).

These research paradigms stem from opposing views regarding the philosophy of knowledge. Morgan (2014) argues that too often the philosophy of knowledge—encompassing ontology, epistemology, and methodology—is treated as an external, objective reality that holds a privileged position in evaluating social science research. Pragmatism offers an alternative to these epistemological debates by focusing on the consequences of actions as the basis for determining truth. In a pragmatist paradigm, the meaning and truth of ideas are determined by their practical effects and usefulness. This view, associated with thinkers like John Dewey and William James, suggests that ideas are true insofar as they "work", that is, they help individuals navigate and solve problems in their lived experiences (James, 1907). Pragmatism sees scientific paradigms as one of many possible ways of thinking that ought to be evaluated by the range of actions they enable.

The pragmatist concept of inquiry is particularly useful within the remit of policy analysis. From a pragmatist perspective, inquiry is viewed as an active, problem-solving process aimed at addressing doubt and achieving practical outcomes, rather than the discovery of absolute truths (Dewey, 1938). Inquiry is thus continuous and contextual, with knowledge being evaluated based on its usefulness in addressing real-world challenges (Hookway, 2016). As James (1907 p.58) noted, "Any idea that will carry us prosperously from one part of our experience to another, linking things satisfactorily and working securely, is true insofar as it proves itself to be useful." Pragmatism, in this sense, aligns well with applied policy analysis, where the goal is often to generate actionable insights rather than abstract theoretical truths.

Within the domain of applied policy analysis, two broad methodological approaches can be identified. One is grounded in quantitative data and econometric models, focusing on identifying statistical and causal relationships, particularly in light of the "credibility revolution" in econometrics (Angrist & Pischke, 2010) but also through more theoretically driven models (Heckman, 2010). This approach emphasises precision in estimating the effects of specific policies, using econometric tools to infer policy impacts. The other approach, often aligned with institutional analysis and

critical realism, mentioned above, engages with broader questions of policy rationale and institutional structures, looking beyond statistical causality to interrogate the socio-political foundations of housing systems. For instance, scholars such as Lawson (2006) and Lawson et al. (2022) provide a comparative perspective on social housing in Europe, focusing on the policy frameworks that shape housing provision and their socio-economic implications. This thesis draws from these two approaches, making use of different theories across the chapters to analyse different facets of housing affordability and decarbonisation.

1.2.2 A progressive ethos

The ultimate objective of this thesis is to explore a progressive approach to the climate crisis through housing. This progressive approach entails accounting for households' economic conditions when determining the benefits and burdens derived from specific policies. In particular, this thesis focuses on the allocation of the costs and benefits of the energy transition across society, what is often called distributional equity. Achieving distributional equity involves both analysing disparities and proposing alternatives to ensure that resources and opportunities are distributed fairly among different populations.

There are multiple definitions of fairness. The energy transition literature offers various definitions of a "fair transition," many of which extend beyond distributional aspects; see Bal et al. (2023) for a recent review. This thesis, however, adopts a narrower approach, based on the understanding of distributional inequalities as the main housing challenge. These inequalities are showcased in the introductory graphs, which emphasise the disproportionate burden of housing costs on lower incomes amid the rising property values of the recent decades. This perspective contrasts with alternative diagnoses often focused on energy consumption or emphasising participation and fairness in decision-making processes.

The focus on distributional inequalities as a central problem to be resolved stems from two ethical principles. The first is the Georgist principle that unearned returns from housing appreciation belong to society. As George (2005 [1879]) argues, the value of land arises not from anything the owner has done, but from widespread economic development. This principle justifies the taxation of land and property, as increases in their value stem from social and economic development rather than individual effort. The second principle is the Marxist axiom: "From each according to his ability, to each according to his needs" (1970 p.19). This principle emphasises redistribution to address societal inequalities and aims to allocate resources to where they are most needed and raise revenue from where it is most abundant.

While Georgists and Marxists hold opposing views regarding the legitimacy of profit—Georgists considering profit from capital legitimate, whereas Marxists do not—this thesis chooses to highlight a key point of convergence. Both perspectives

recognise that wealth generated through collective processes and the costs arising from societal transformations should be distributed equitably across society. This shared understanding reinforces the case for progressive taxation and public intervention as essential tools for redistribution, particularly in the context of the energy transition. By situating housing within these broader principles of equity, this thesis explores the alignment of housing affordability and environmental objectives.

Inequity across households can be understood through two primary dimensions: horizontal inequity and vertical inequity. Tackling vertical inequity pertains to the redistribution of resources from wealthier to poorer individuals, aiming to achieve greater societal balance. Horizontal inequity, on the other hand, occurs when individuals in similar circumstances experience unequal treatment, with one group deriving disproportionate benefits (Barr, 1998). However, inequality regarding housing affordability complicates this distinction, as housing affordability is related to both income, a vertical dimension (Ben-Shahar & Warszawski, 2016), as well as wealth inequalities. The last often stem from a differential treatment of housing tenures, lack of tenure neutrality (Christophers, 2021; Haffner, 2003), arguably a form of horizontal inequality.

Beyond the measurement of inequalities at the household level, the housing literature has also problematised strategic choices at the system level. Housing inequalities arise from specific institutional arrangements for housing provision. A rich international comparative literature has investigated how these arrangements mediate access to housing markets and significantly influence housing provision (Aalbers, 2022; Boelhouwer & Heijden, 1992; Kleniewski & Harloe, 1996). This body of research underscores the complexities of housing strategies, highlighting the need for a deep understanding of institutional frameworks and their broader socio-economic impacts.

Housing and climate are deeply entwined with questions of economic and social distribution—spanning incomes, tenures, and the institutions that mediate access to housing. Ultimately, this thesis explores different facets of housing inequalities and problematises policy choices about housing made within the frame of the energy transition.

1.2.3 Scope: affordability and provision

This thesis explores the intersection between housing affordability and decarbonisation by contextualising housing costs and provision within the energy transition. It comprises a series of stand-alone essays that explore housing issues relevant to the design of policies for the energy transition drawing on both qualitative and quantitative evidence. The individual essays collectively span various contexts in Northern, Southern and Central European countries. These essays analyse how different policies, such as fiscal incentives, regulatory measures, and information

interventions, affect housing provision and costs. A first group of essays dives into how decarbonisation policies influence housing costs for different groups, including homeowners, mortgagors, and renters. A second group of articles seeks to understand how different policies, including sustainable finance, homeownership subsidies and land provision for social housing, interact with existing housing structures and institutions. By incorporating evidence from multiple disciplines and contexts, this dissertation highlights the role of housing in the energy transition, while offering actionable insights on demand and supply-side strategies that enhance affordability and stimulate investment.

A precise mapping of housing and environmental policy boundaries is particularly challenging due to the interconnected and cross-cutting nature of these policy areas concerning multiple actors and levels of government. Political scientists often categorise policy instruments into three main types: carrots (financial incentives), sticks (regulations), and sermons (information campaigns), following Bemelmans-Videc et al. (1998). While this framework provides a starting point, its application to specific policy domains, such as housing or decarbonisation, is far from straightforward. For instance, Economidou et al. (2020) propose four additional categories when considering the EU's energy efficiency policies. These include infrastructure investment and vocational training programs showcasing the complexity of classifying policies when they encompass both technical and social dimensions. Similarly, Bertoldi et al. (2021) also provide a systematic classification of renovation policies according to market saturation (traditional, growing and new) and type (non-repayable reward, debt financing, and equity financing).

A recent OECD report (2024) on building decarbonisation takes a different approach to decarbonisation policies and differentiates between mandatory energy efficiency codes in new build, financial incentives, mandatory energy performance certificates, regulations on whole-life carbon and Minimum Energy Performance Standards. This approach focuses exclusively on policies targeting the physical aspects of the built environment. However, in doing so, it leaves out other policy domains, particularly those related to financial markets, which also exert a considerable influence on investment costs. Since housing is a capital-heavy industry, financial regulations have historically played a very significant role in house prices, for instance through the failure of macroprudential regulations in the 2008 crisis (Andrews et al., 2011).

In the current landscape, the financial sector is vulnerable to the climate crisis in part due, on the one hand, to changes in real estate valuations, as highlighted in an ECB report on climate risks (European Central Bank, 2022). Particular regulatory actions in the built environment, i.e. the introduction of Minimum Energy Performance Requirements, may alter the value of real estate and have an impact on the balance sheet of both households and financial institutions (Ferentinos et al., 2021). On the other hand, disclosure requirements and the labelling of funds and investments as sustainable has the potential to guide investment towards greener housing provision (Schoenmaker & Schramade, 2019). Sustainable finance regulations, though at the intersection of environmental regulation and housing finance have not been traditionally categorised as housing policy. However, over the last decades, building regulations have actively shaped investment decisions in the built environment as the

hedonic pricing literature has showed [1].

Despite the relevance of financial and environmental regulations, housing policy has traditionally been understood in a narrow manner as social or urban policy. On the social side, housing was seen as targeting households in need through allowances, tax deductions, grants, or directly allocating social housing (Barr, 1998). On the urban side, housing was seen as a matter for architects and planners, mostly occupied with informal housing and participation (UN Habitat, 1976). However, over the last decades the implications of multiple public policy decisions on housing have broadened the traditional "housing" field. Clapham (2018) offers a broad definition of housing policy as any government action that influences housing processes or outcomes. This expansive definition encompasses not only policies typically overseen by housing ministries but also macroeconomic policies, such as inflation targeting, which have profound implications for housing affordability. Similarly, Meen & Whitehead (2020) also suggest that housing policy must be understood as operating across multiple domains, from fiscal measures to monetary policy. For instance, Stephens (2024) highlights the central role that monetary policy committees play in shaping housing costs and the views that inform these processes, as interest rates set by central banks directly impact mortgage rates, thus determining the affordability of homeownership.

This thesis adopts a broad understanding of housing policy, addressing topics that extend beyond traditional housing research. It explores areas such as sustainable finance—arguably outside the typical purview of housing researchers—and renovation subsidies, which are often framed solely as energy issues but here are examined in relation to housing fiscal policy. The specific topics of each paper have been chosen following a capita selecta approach where the point of departure is usually set by regulatory changes, sticks, at National level or long-term objectives stemming from EU policies such as the Energy Performance of Buildings Directive (EPBD). Alongside these regulatory aspects, carrots, fiscal policies—particularly subsidies and taxation—also come to the fore due to their significant influence on housing costs and provision. Together with them, informational tools, sermons, such as financial disclosure requirements and climate risk assessments, which are expected to play a relevant role in directing private investment toward sustainable housing solutions, become an integral component of this analysis. Conversely, this study excludes broader market interventions such as grid management and labour-focused training programs, which, while important to the energy transition, are less directly tied to housing affordability and provision.

As opposed to the systematic classifications presented above (Economidou et al., 2020; Bertoldi et al., 2021; OECD, 2024), this thesis focuses on the evolution of housing affordability in the face of housing renovation and interrogates the rationale of certain strategic decisions in housing provision. In doing so, the thesis follows a capita selecta approach. This results in a non-systematic exploration of countries and topics, privileging depth over breadth in particular areas. Rather than a cohesive cross-country comparison, this dissertation is centred on a series of topics chosen

[1] See for instance Eichholtz et al., (2010) for one of the first papers on the topic focused on commercial property.

because of their academic and policy relevance. While the structure section of the dissertation provides a detailed account of how each chapter logically contributes to the overall argument, it is worth briefly highlighting the rationale behind certain thematic choices here.

In Part I of the dissertation, the chapters are centred on renovation subsidies, addressing this policy because of its prominence within national decarbonisation strategies as one of the most widely implemented mechanisms to incentivise renovations(Bertoldi et al., 2021; OECD, 2024). To varying extents, these policies -or similar ones through tax credits- operate or have operated in at least three of the studied countries, England, the Netherlands and Spain, but are also common beyond them, for instance, in the USA (Borenstein & Davis, 2016) and Italy. The italian case is particularly extreme since homeowners who improve their Energy Performance Certificate (EPC) by at least two classes may claim a tax credit equal to 110 % of eligible renovation expenditures, up to a maximum of €96 000 (Codogno, 2024).

In contrast, the chapters in Part II—focused on housing provision and strategy—engage more directly with the policy challenges identified by non-academic partners within the RE-DWELL project. RE-DWELL was an EU-funded International Training Network (ITN) under the Marie Skłodowska-Curie Actions (MSCA) which provided financial support and institutional framing for this dissertation. Bringing together scholars and practitioners from across Southern, Northern, and Eastern Europe, the network facilitated a transdisciplinary environment through the exchange of expertise between academia and practice. This thesis is situated within the Policy and Financing Pillar—one of RE-DWELL's three core dimensions, alongside Design and Participation—and examines the financial and distributional impacts of the energy transition on housing systems. The selection of case studies was directly shaped by academic secondments to CERANEO in Zagreb, Housing Europe in Brussels, and INCASOL in Barcelona. These placements provided in-depth, practice-based insights into the governance and financing of affordable housing, enabling a grounded analysis that connects policy frameworks with operational realities.

This case-selection strategy—anchored equally in policy relevance and in the concrete needs of RE-DWELL's non-academic partners—yields a deliberately unconventional scope within the capita selecta framework. By privileging real-world concerns over theoretical alignment, this dissertation has chosen topics that speak directly to pressing policy debates while simultaneously addressing stakeholder priorities within RE-DWELL. Returning to the pragmatist research paradigm introduced above, this dual focus contextually grounds the dissertation and centres it on the formulation of applicable insights rather than on the pursuing of abstract generalisations or "universal truths". In so doing, the thesis aims to produce both academically robust analysis and also actionable recommendations, fulfilling its commitment to scholarship that is both rigorous and socially relevant.

1.3 Problem Formulation

1.3.1 Research problem

This thesis investigates the impact of decarbonisation on housing costs and provision, positioning itself at the intersection of environmental and social challenges. The point of departure consists of the three housing dimensions presented above: the uneven distribution of housing costs, the undertaxation of homeownership, and the financing of social housing through hybrid frameworks. While these three dimensions mediate the impact of environmental policy on housing affordability and provision, they are often overlooked in debates about climate policy. This study bridges social and environmental dimensions, focusing on the distributional consequences of different approaches to housing decarbonisation. By situating environmental policies within the housing context, this thesis fosters the recognition of tensions between achieving decarbonisation and ensuring housing affordability.

1.3.2 Research Gap

The research gap revolves around the relationship between sustainability, housing affordability, and the policy and financing mechanisms used to deliver on these two priorities. On the one hand, research has largely neglected the socioeconomic impacts of housing renovation policies on affordability and equity. On the other hand, recent regulatory developments underscore the need to examine changes in housing provision systems and how they interact with the energy transition.

First, despite the pan-European impulse to decarbonisation and energy efficiency, there is a significant gap in understanding the socioeconomic and financial implications of these policies. On the one hand, the economics literature has focused on property premiums arising from energy efficiency improvements, using hedonic pricing models (Fuerst et al., 2020; Wilkinson & Sayce, 2020). In this regard, the main vector for the study of the distributional impacts of energy savings have been related to energy poverty-related discrepancies between theoretical performance, as stated in Energy Performance Certificates (EPCs), and actual energy consumption (Sunikka-Blank & Galvin, 2012) (Brom et al., 2019). However, by focusing on energy impacts this approach neglects the impacts generated by variations in housing costs themselves. On the other hand, housing research has not deeply engaged with decarbonisation beyond integrating energy costs into housing affordability measurements (Haffner & Boumeester, 2015). This leaves a gap in understanding how policies designed to decarbonise housing impact affordability and distributional equity.

Second, the research gaps this thesis addresses also stems from recent policy changes. Over the last years, the financing landscape for Environmental, Social, and Governance (ESG) initiatives has undergone significant transformations, particularly with the implementation of major regulatory frameworks such as the Sustainable Finance Disclosure Regulation (SFDR), which entered into force on March 10, 2021, and the EU Taxonomy Regulation, whose first delegated acts became applicable on January 1, 2022. These changes have redefined how sustainability goals are financed, monitored, and reported, creating new challenges and opportunities for housing policy research. National level developments have also shaped the research focus on policies. For instance, Spain introduced a landmark housing law on May 26, 2023, sparking debates about new social housing developments. Similarly, Croatia is in the process of designing a new housing policy, which reflects ongoing political and legislative discussions about housing provision. Such legislative shifts create opportunities to advance research on how housing policies are adapting to contemporary environmental and social challenges all while building and updating recent institutional research on affordable housing finance (Scanlon et al., 2014) (Lawson et al., 2022).

1.3.3 Main research question and aim

Main Research Question: How does decarbonisation affect both the distribution of housing costs and housing provision in Europe?

Aim: This dissertation explores how decarbonisation affects both housing costs and their distribution, as well as the interplay between policy design and institutional frameworks for housing provision. The main objective is to integrate environmental issues into the study of housing policy and affordability, highlighting tensions between environmental and social dimensions. By critically assessing environmental policies through a housing lens, this study analyses how housing inequalities are embedded in and perpetuated by the transition to net-zero.

1.4 Structure and Subsections

This section outlines the two-part and three-subsection structure of the thesis (See Table 1). Comprising six essays, the thesis investigates housing provision and decarbonisation policies across various European and national contexts. The organisation of the thesis provides two itineraries to read the essays, across

methodological or thematic lines, while also presenting them as interconnected components of a cohesive argument.

1.4.1 Methodologically aligned parts and summary of individual chapters

This thesis is methodologically structured into two main parts: Affordability and Costs (Part I) and Provision and Finance (Part II). Part I, with a quantitative focus, examines the costs and affordability of decarbonisation, aiming to assess its financial impact on households. In contrast, Part II adopts a qualitative approach, exploring the financing and management of decarbonisation and housing provision. This two-part division acknowledges the diverging departure points of quantitative policy analysis on the one hand, and institutional or critical approaches to housing systems on the other.

Second, the thesis is further organised into three sections that juxtapose diverse types of evidence and provide a topical and policy-focused reading of the different chapters. This division aims to elicit discussion across disciplines cutting across paradigms by focusing on empirical results. The sections are thought of as prompts for interaction, presenting points for encounter between the essays. Section A sets the scene regarding housing provision, section B focuses on current decarbonisation policies and section C collects the propositional essays presenting alternative pathways (See Table 1).

TABLE 1.1 Thesis' Structure

Part 1: Affordability and Costs	Part 2: Provision and Finance
Section A: The Set-Up. Housing Prices, Impacts and Rationale	
Chapter 2 Investigating the impact of housing price increases on consumption: heterogeneity by age, tenure, and housing quality	**Chapter 5** The Role of Mortgage Subsidies in the Croatian Economic Growth Strategy: a Political-Economy Approach to the SSK
Section B: Current Policies. Decarbonisation and Inequality	
Chapter 3 Unequal rewards to decarbonisation: a diff-in-diff approach to measuring housing costs across tenures	**Chapter 6** Three contradictions between ESG finance and social housing decarbonisation: a comparison of five European countries
Section C: Alternative Pathways	
Chapter 4 Subsidies or green taxes? Evaluating the distributional effects of housing renovation policies among Dutch households	**Chapter 7** When Land is Not Enough: Attracting Private Investment to Expand Social Rental Housing in Spain

Part I, encompassing chapters two, three, and four, examines the financial impact of decarbonisation on households. This section employs quantitative methods, including large household-level datasets and various forms of regression analysis, to measure changes in housing costs. It investigates how different demographic and economic factors mediate the affordability of decarbonisation initiatives. By assessing variations along socio-economic lines, this part provides an analysis of the financial burden on households and identifies potential disparities in the cost distribution of decarbonisation efforts.

Chapter two investigates the effect of rising house prices on non-housing consumption, an indicator of living standards. In merging data from the 2009 to 2019 waves of the English Housing Survey (EHS) and the Living Costs and Food Survey (LCFS), this chapter lays the groundwork for the joint analysis of housing affordability and energy efficiency. The econometric approach uses pseudo-panel regressions to highlight varying consumption responses to house price changes across age, tenure, and energy efficiency levels. A key finding is that older homeowners in energy-efficient homes increase their non-housing consumption more in response to rising house prices compared to younger ones. This raises important questions about the distribution of housing wealth and its impact on non-housing consumption.

Chapter three expands on the distributional implications of decarbonisation by assessing how it influences housing costs across tenures, focusing on the differential impacts on renters and homeowners. Drawing from a large registry dataset, this essay measures changes in housing affordability through a difference-in-differences regression over a matched set of decarbonised and non-decarbonised households. The findings reveal differing percentage reductions in housing costs across tenures. A welfare analysis further explores how the capitalisation of cost savings might affect welfare distribution, highlighting a potential advantage for homeowners over renters.

Chapter four takes a more propositional approach by examining the distributional implications of Dutch housing renovation policies. Through a simulation, it contrasts the impacts of direct subsidies and a proposed green tax on the financial viability of renovations and the distribution of housing costs. This chapter concludes that subsidies exacerbate regressive tax effects, disproportionately benefiting wealthier homeowners. Conversely, linking property taxes to energy efficiency reduces fiscal inequality and encourages renovations, demonstrating how energy-efficiency-linked property taxation can make the fiscality of homeownership less regressive while incentivising renovation.

Part II, comprising chapters five, six and seven, shifts the focus to Provision and Finance, exploring how decarbonisation and housing provision initiatives are financed and managed at national and European levels. These essays were written during short-term secondments, two to three months, with non-academic partners in Zagreb, Brussels, and Barcelona as explained above. Formulated in close collaboration with practitioners, they draw primarily from semi-structured interviews to understand the practical concerns of those involved in various forms of housing provision and management.

Chapter five investigates homeownership subsidisation in Croatia, serving as an introduction to the rationale of homeownership subsidisation from a political-economy perspective. Drawing from interviews with relevant stakeholders, descriptive data indicators, and a review of policy documents, this chapter characterises the SSK subsidy as a move toward financialised growth through asset price increases. Ultimately, SSK is situated within a broader social policy shift focused on mortgage markets, furthering the privatisation of the welfare state and favouring middle-income groups.

Chapter six examines the introduction of ESG (Environmental, Social, and Governance) legislation and its effects on the financing of social housing decarbonisation across Western Europe. The main data source are semi-structured interviews with senior finance professionals in Social Housing Providers (SHPs) in France, the Netherlands, Austria, Germany, and Denmark. The results point out contradictions and challenges in aligning financial markets with social housing renovation. The findings highlight contradictions and challenges in aligning financial markets with social housing renovation, mapping the limitations of market-based mechanisms for financing these efforts.

Finally, Chapter seven tackles the institutional dynamics and financial constraints that hinder social rental housing provision at scale in Spain. It does so through a series of interviews and financial project data analysis related to a particular case study of a public-private partnership (PPP) in Barcelona. This paper ultimately offers avenues to reform social housing provision in Spain that operate within current public debt constraints, drawing private investment and delivering on social objectives.

1.4.2 Thematically structured sections across disciplines

Beyond its two-part, methodologically driven structure, this thesis is further organised into three subsections that juxtapose diverse types of evidence. These subsections encourage an integrated reading of the essays, bridging both quantitative and qualitative evidence across the two scales of household and system (see Table 1).

The first subsection comprises chapters two and five. Chapter two examines the impact of house price increases on consumption in the UK, while Chapter five explores the political economy of house value appreciation in Croatia. Article four builds on the rationale behind house price appreciation, a process whose effects are analysed in chapter two. The aim is to challenge a housing policy model centred on homeownership by highlighting its distributional impacts on consumption and discussing its implications for decarbonisation.

The second section, comprising chapters three and six, examines the current impact of decarbonisation on households and social housing systems. Chapter three utilises

Dutch registry data to investigate how decarbonisation influences housing costs, while Chapter six adopts a comparative approach across five European countries to analyse the effects of financial market greening on social housing finance. While chapter three explores impacts across tenures, chapter six evaluates the influence of EU legislation on national social housing systems. Together, these chapters critically assess contemporary decarbonisation strategies emphasising their distributional implications and the potential to reinforce economic inequalities.

The third section is more explicitly oriented towards policy recommendations. Chapter five deals with the potential of energy efficiency-linked housing taxation in the Netherlands for a progressive housing transition. Chapter 6 draws from a case study of a PPP in Barcelona to propose policies that increase social housing supply in Spain. These two essays share a common goal of questioning the current choice of instruments, subsidies for homeowners and market financing for social housing, and propose alternative pathways for housing development and renovation.

Ultimately, the thesis progresses from understanding consumption and affordability impacts (Chapters 2–4) to exploring policy instruments and financial mechanisms (Chapters 5–7). By integrating diverse methodologies and national examples, the research addresses both quantifiable and institutional dimensions of housing decarbonisation and affordability, ultimately contributing to policy debates on sustainable and equitable housing.

1.5 Specific Research Objectives, Sub-Questions and Methods

This section outlines the specific research objectives, sub-questions, and methods employed across the six essays that comprise this thesis. Each essay investigates distinct but interrelated aspects of housing decarbonisation, policy impacts, and affordability in Europe. Through a combination of national studies and comparative analyses, the thesis contributes to broader debates by exploring both EU-level policies and micro-level household costs. The essays are linked by a shared focus on distributional effects, affordability challenges, and the intersection of housing and decarbonisation policies. The specific aims outlined for each chapter operationalise the broader research gaps identified earlier centred around the distributional implications of decarbonisation and the impact of new renovation and provision policies on housing systems. The research objectives span multiple dimensions of housing policy and decarbonisation, addressing specific national contexts while producing insights into broader trends.

TABLE 1.2 Research Objectives per Chapter

Chp.	Objective	Area
2	To assess the influence of house prices on household consumption across age groups, tenures, and efficiency standards.	UK
3	To evaluate the impact of decarbonisation policies on housing costs across tenants and homeowners.	NL
4	To analyse the distributional effects of housing renovation subsidies under various tax scenarios.	NL
5	To unpack the political rationale behind the subsidisation of homeownership as part of national strategies for growth and welfare.	HRV
6	To investigate the effects of ESG legislation on financing mechanisms for the decarbonisation of social housing.	NW EU
7	To identify financial and institutional impediments to large-scale social housing provision and possible paths for reform.	SP

The research sub-questions connect the broad aims of the thesis to the specific objectives within each chapter. This progression ensures that each chapter maintains a clear focus, allowing for a geographically grounded exploration of housing decarbonisation and affordability dynamics. Additionally, it ensures that localised insights contribute meaningfully to the overarching research question. By addressing distinct but interrelated sub-questions, the chapters together highlight the diverse impacts of housing decarbonisation policies across different contexts. This structured approach enhances the coherence of the thesis, linking case studies to broader policy discussions and theoretical debates.

TABLE 1.3 Research Sub-Questions per Chapter

Chap.	Sub-Question
2	How do house prices affect household consumption across age, tenure, and energy efficiency standards?
3	How does decarbonisation impact housing costs across different tenures?
4	How do the financial incentives and distributional impacts of housing renovation policies vary across different tax scenarios?
5	How does mortgage subsidisation position the Croatian housing market within the national strategy for economic growth and social policy provision?
6	How does the introduction of ESG legislation affect the financing of social housing decarbonisation?
7	How does the interaction of institutional dynamics and financial constraints influence the provision of social rental housing in Spain?

The methods employed in each chapter are selected to both address the sub-questions effectively and make use of the opportunities provided by the RE-DWELL project. Quantitative methods dominate the early chapters, where econometric techniques such as pseudo-panel regressions (Chapter 2) and difference-in-differences analysis (Chapter 3) provide statistical insights into the relationships between housing costs, decarbonisation policies, and their effects on households. As the focus shifts to policy rationales and systemic challenges in later chapters, qualitative methods come to the forefront. Semi-structured interviews (Chapters 5 and 6) capture nuanced perspectives on the political economy of housing and the implications of ESG legislation. Chapter 7 synthesises both approaches, combining qualitative data from interviews with quantitative modelling through a discounted cashflow model analysis to evaluate financial and institutional barriers to social housing development in Spain. This methodological diversity reflects the thesis's transdisciplinary approach, allowing for a comprehensive examination of housing decarbonisation policies across different contexts and scales. The integration of these methods ensures that each chapter not only answers its specific sub-questions but also contributes to the thesis's overarching narrative about the intersections of housing, affordability, and sustainability.

TABLE 1.4 Methods in Relation to Research Objectives

Chap.	Methods	Explanation
2	Quantitative: Pseudo-panel regressions	This study employs pseudo-panel regression on longitudinal data to examine distributional impacts across demographic groups, housing tenures, and energy efficiency standards in the energy transition.
3	Quantitative: Matching and diff-in-diff	Using registry data, the analysis applies matching and difference-in-differences methods to assess the effects of decarbonisation on housing costs, focusing on affordability for tenants and homeowners.
4	Quantitative: Regression, marginal costs, simulation of user costs	Marginal benefits and costs of renovation are estimated through regression and government data, simulating changes in user costs across income deciles under various policy scenarios to evaluate policy equity and efficiency in subsidies and green tax scenarios.
5	Qualitative: Semi-structured interviews, policy review, descriptive statistics	This essay employs a qualitative approach to explore the economic drivers behind homeownership subsidisation, integrating policy review, interviews, and descriptive statistics to explore its economic and welfare implications.
6	Qualitative: Semi-structured interviews, policy review	Semi-structured interviews with stakeholders capture the financial and regulatory challenges in accessing sustainable finance, focusing on ESG alignment for social housing providers.
7	Mixed: Semi-structured interviews, policy review, descriptive statistics, and financial analysis	The study explores financial and institutional barriers to large-scale social housing provision, combining qualitative interviews with financial modelling to identify constraints and propose reforms.

1.6 Research Contribution Objectives

This section is structured into two areas: scientific contributions, which advance theoretical and empirical research, and societal contributions, which advance policy design and implementation.

1.6.1 Scientific contributions

This thesis aims to contribute to scientific knowledge in three areas: developing a joint analysis of housing affordability and decarbonisation, offering new measurements of housing affordability in the energy transition, and examining the impact of emerging financing frameworks on affordable housing provision.

First, this thesis addresses a gap in the analysis of the socioeconomic impact of decarbonisation policies on housing affordability and equity. Much of the academic literature has focused on energy consumption-related elements of decarbonisation (Sunikka-Blank & Galvin, 2012) (Brom et al., 2019) and on property valuation issues arising from housing quality improvements (Fuerst et al., 2020; Wilkinson & Sayce, 2020). However, the interlock between energy and housing dimensions remains underexplored (Burlinson et al., 2018). By investigating these intersections, this thesis advances the literature on integrating energy costs into housing affordability measurements (Haffner & Boumeester, 2015). The development of this connection instantiates a pragmatist research paradigm focused on the reduction of inequalities. The aim is to reframe renovation and decarbonisation policies as more than purely energy-focused interventions by embedding them within the larger context of housing systems. In doing so, the thesis draws from a long-standing research tradition on housing reform (Yates, 1989) as well as more recent policy analysis that aim to deliver on both social and environmental objectives (Muellbauer, 2023).

Second, the thesis offers empirically grounded contributions through a joint analysis of building quality and socioeconomic indicators, enabling a nuanced and novel exploration of the interlinkages between environmental and social objectives. Methodologically, this thesis advances the study of housing affordability by moving beyond traditional metrics such as ratios and point-in-time statistics, following on the work of Ben-Shahar and Warszawski (2016). The implications of housing affordability changes are to be measured by drawing from both economic theory, user costs, (Poterba, 1984), and empirical econometric modelling techniques, such as difference-in-differences (DiD) analysis. This thesis aims to contribute to the field by unpacking the uneven financial burdens of decarbonisation over time and across tenures. Through the analysis of housing affordability together with environmental objectives this thesis seeks to explore how these measures interact with the existing distribution of housing costs, shedding light on the nesting of environmental and social inequalities.

Third, this thesis advances the study of housing policy by examining the impact of recent legislative changes on housing provision. The main contribution lies in the novel topics resulting from recent policy changes. First, the thesis addresses the socioeconomic rationale for the implementation of homeownership subsidies in Croatia in 2017. In doing so, it contributes to the literature on post-socialist housing (Hegedüs et al., 2013) and welfare through mortgage markets (Schelkle, 2012). Second, the project also fills in a gap in the comparative literature on social housing provision, i.e. (Norris & Byrne, 2021) (Scanlon et al., 2014), produced by recent EU legislation on ESG finance, namely the Sustainable Finance Disclosure Regulation

(SFDR) (Regulation (EU) 2019/2088) and Green Taxonomy (Regulation (EU) 2020/852). Third, the thesis also examines Spain's new Law on the Right to Housing (12/2023), passed in 2023, with a special focus on the measures proposed to increase the social housing stock building on prior assessments of housing policy in Spain (Pareja Eastaway & Varo, 2002; Pareja-Eastaway & Sánchez-Martínez, 2022). These assessments highlight how evolving regulations shape housing provision and financial incentives, offering novel insights into the intersection of housing policy and environmental goals.

1.6.2 Societal contributions

This thesis, grounded in a pragmatist research approach, is embedded in societal debates about housing affordability and centred on the production of actionable insights. On the one hand, it sets out to provide empirical evidence on the distributional impact of decarbonisation policies, such as those analysed in chapters two and three. By shedding light on how these policies affect different socio-economic groups, the thesis contributes to nuanced policy design that prioritises equity alongside environmental objectives (Chapter 4). It aims to inform political debates on affordability by articulating how decarbonisation strategies can exacerbate or alleviate existing inequalities, offering policymakers critical insights for policy design. In advancing discussions on redistribution and equity, the research intends to identify alternative pathways for a progressive transition to net-zero. This alignment of environmental and social goals reflects the pragmatic aim of the thesis: to explore the limitations of existing policies while proposing implementable, equity-focused alternatives that support long-term sustainability.

On the other hand, it bridges the gap between academic inquiry and housing practitioners working on provision and finance. Conducted as part of the RE-DWELL project, this research was developed in close collaboration with non-academic partners such as housing organisations and policymakers. This transdisciplinary approach aimed to address challenges in housing provision by integrating research and practical applications. Through the incorporation of practitioners' experiences, this thesis contextualises theoretical insights within the constraints of actual policy implementation, providing a more grounded understanding of how policies become operational. Chapters five, six, and seven draw on qualitative fieldwork and semi-structured interviews with stakeholders such as policymakers, housing providers, and finance professionals. Their expertise informs the analysis of practical challenges, offering actionable recommendations to align financial mechanisms with affordability and sustainability goals. For example, the exploration of Barcelona's public-private partnership highlights how innovative governance structures can improve housing affordability despite financial and institutional constraints. By engaging directly with practice, this thesis aims to go beyond abstract critique, delivering strategies that aim to be both theoretically sound and also viable in practical settings.

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PART 1 Costs and Affordability

Part 1 examines the impact of housing renovation on affordability through three distinct lenses: consumption, costs and assets. The first chapter in this part delves into household consumption and its connection to house prices, considering variations in age, tenure, and energy efficiency. This first chapter sets the scene by analysing the impact of housing appreciation on consumption across different tenures and age groups. Building on this, the second chapter uses registry data to analyse the effects of decarbonisation on total housing costs, tracking households over time and constructing a counterfactual to compare renovated and non-renovated housing units. The third chapter shifts focus to asset appreciation and redistribution, applying the concept of user cost of capital to evaluate the distributional impacts of two policies: a direct subsidy and a green tax. Hence, these last two chapters operate as two sides of the same coin focusing on costs and asset value respectively.

While all three chapters draw on household-level datasets, they adopt different methodological approaches. The first integrates data on consumption and housing quality, while the second implements a diff-in-diff analysis and matching to produce a counterfactual modelling differentiated outcomes across tenures. The third chapter applies an economic model of marginal costs and benefits and the concept of user cost of capital to evaluate policy impacts on financial viability and equity. Together, these studies analyse the distributional dynamics of housing renovation, highlighting key trade-offs in affordability and equity under different policy scenarios. In bringing these three approaches together, this first part weaves together the multifaceted implications decarbonisation policies for housing affordability.

2 Investigating the Impact of Housing Price Increases on Consumption

heterogeneity by age, tenure, and housing quality

Abstract [1]

This study examines the distributional impact of house price increases on household consumption, focusing on differences across household types and the role of energy-efficient homes in the context of the energy transition. Using data from the English Housing Survey (EHS) and the Living Costs and Food Survey (LCFS), the analysis employs pseudo-panel regressions to estimate the Marginal Propensity to Consume (MPC) in response to changes in house prices. The findings reveal varied consumption responses based on age and tenure. Older homeowners tend to increase consumption when house prices rise, while middle-aged individuals, particularly renters and mortgage holders, tend to reduce consumption. Younger households also exhibit a positive consumption response but to a lesser degree than older homeowners. Additionally, energy-efficient homes are generally associated with lower consumption across tenure groups, though when interacted with house prices and age, the estimates suggest unequal benefits from property price premiums based on housing market positions. The study highlights the limitations of the pseudo-panel approach, including potential unobservable selection bias and a small sample of energy-efficient homes, which may affect the robustness of the results. The findings suggest that energy transition policies focused on subsidizing homeowner renovations may disproportionately reduce consumption among younger and middle-aged households. This paper contributes to the MPC literature by incorporating energy efficiency as a key factor, offering new insights and policy implications for housing retrofit in the context of the energy transition.

[1] This chapter has been published as: Fernández, A. (2024). Investigating the impact of housing price increases on consumption: Heterogeneity by age, tenure, and housing quality. Journal of European Real Estate Research, 17(2), 232–262. https://doi.org/10.1108/JERER-11-2023-0043. Minor modifications have been made to the text as well as the abstract for it to be in line with the other chapters.

2.1 Introduction

In 2019, the UK committed to achieving net-zero CO2 emissions by 2050, with housing decarbonisation, accounting for 19% of all emissions, playing a pivotal role in its strategy (BEIS, 2019; BEIS, 2020). A key policy proposal is the enhancement of Energy Performance Certificates (EPCs), a measure of energy consumption, from an average rating of D to C by 2035 (ONS, 2020). This improvement is projected to require an investment of £35–£65bn in housing retrofit, with at least £1bn per year expected to come from public grants (BEIS, 2019). The financial feasibility of these renovations depends on two factors: the ability of energy savings to offset retrofit costs and the capitalisation of these savings in house prices, known as the energy efficiency premium.

The academic literature has increasingly focused on property premiums arising from energy efficiency improvements, using hedonic pricing models as proposed by Rosen (1974). These models view housing as a heterogeneous good with individual characteristics that can be priced separately. Over the past decade, Rosen's model has been extensively applied to EPCs, with studies in the UK, the Netherlands, Spain, and Sweden all reporting a positive impact of energy efficiency on house prices (Fuerst et al., 2015; Brounen & Kok, 2011; Ayala et al., 2016; Cerin et al., 2014). A comprehensive meta-analysis by Wilkinson & Sayce (2020) confirms this trend, although the magnitude of the premiums varies by country and building type.

However, the literature also reveals a discrepancy between theoretical performance, as stated in the EPC, and actual energy consumption. Sunikka-Blank & Galvin (2012) propose the existence of pre and re-bound effects, where energy consumption in inefficient dwellings is lower than expected, and consumption in energy-efficient dwellings is higher. This disparity has also been observed in the Netherlands, with Brom et al. (2019) finding that post-renovation energy savings are dependent on household composition among other variables. Recent behavioural approaches have considered the risks of uncertain energy savings related to investment recoup from renovation in homeowner decision-making (Ebrahimigharehbaghi et al., 2022). However, the distributional impacts of these type of built fabric interventions have only recently started to be explicitly explored. McCoy & Kotsch (2021) draw from a large dataset of energy consumption pre and post-renovation to study heterogeneity in energy savings in the UK. They focus on household deprivation and the type of built-fabric intervention to show that investments targeting less well-off households may in fact be ineffective in reducing energy use.

The granularity and distributional impacts of micro-level studies contrast with macro-level research, which has underscored the positive impact of large-scale housing retrofit. National housing renovation strategies are anticipated to stimulate GDP growth by fostering increased public and private investment, thereby creating jobs with low-entry requirements in the construction sector, as exemplified by the Spanish case (Santiago-Rodriguez, 2021). At a macro level,

Environmental-Energy-Economic models have proven instrumental in analysing the interplay between energy production and the economy (Cazcarro et al., 2022). However, these models often lack micro-foundations. When such foundations are present, they tend to focus more on accounting for issues of built fabric and energy savings heterogeneity rather than household characteristics (Fotiou et al., 2019; Fotiou et al., 2022).

The renovation of the housing stock is set to occur in a context of escalating property values, which have only been slightly offset by a minor reduction in prices over the past year. This paper draws from the economic literature on housing price shocks to contextualise energy efficiency improvements within the literature on household consumption. The capacity of house price increases to influence consumption has been a significant area of economic investigation. Micro studies utilising panel data (Suari-Andreu, 2021), pseudo panel (Campbell & Cocco, 2007), and macro time-series (Aoki et al., 2004) have yielded widely varying estimates across tenure (Berger et al., 2018) and age groups (Li & Yao, 2007). Building on this literature, this paper explores the question, "How do house prices affect household consumption across age, tenure, and energy efficiency standards?" The paper's primary focus is analysing the relationship between the Marginal Propensity to Consume (MPC) and fluctuations in house prices. To this end, this study delves into the interplay between household age, building quality, tenure, and MPC. The analysis is centred around two main aspects. Firstly, whether older cohorts, who are more likely to own their homes outright and have larger amounts of equity, exhibit a larger MPC out of house price shocks. Second, the role of building quality in mediating this relationship between household age, tenure and house prices. This analysis leverages a combination of two micro cross-sectional datasets: the English Housing Survey (EHS), which provides data on the housing stock and its inhabitants, and the Living Costs and Food Survey (LCFS), which offers detailed consumption and financial information.

The remainder of this paper is organised as follows: section two reviews the literature on MPC and housing price shocks, along with the main empirical and methodological divergences. Section three discusses the data background and the predictive modelling of energy efficiency ratings, combining EHS and LCFS datasets. Section four proposes a series of models to estimate MPC out of changes in house prices. Section five discusses the findings and shortcomings of the approach at hand. Section six addresses the policy implications of retrofit funding models, and section seven concludes.

2.2 Literature Review

The link between house prices and consumption has been a focus of economic research particularly since the 1980s as cycles of housing booms and busts have become a prevalent phenomenon across Europe and the US. This section focuses first on the different channels through which house prices affect consumption and then discusses the wide range of estimates and methodological divergencies in the study of MPC.

On the one hand, the Permanent Income Hypothesis (PIH), predicts that consumption reactions to house price fluctuations should be small as these are offset by future implicit rental costs for a majority of households that are "short" in housing leaving budget constraints unchanged. Sinai and Souleles (2005) tested this assumption empirically with US micro-data and found that the probability of ownership increases with rent risk and the net risk of owning declines as the expected horizon of ownership rises. Following the PIH, in the UK, Campbell and Cocco (2007) find a larger consumption response to increases in house prices among households that are "long" in housing, that is older households with higher equity. On the contrary, for households that are not credit constrained, these changes in value have no impact on consumption. Buiter (2008) explores the absence of a "pure-wealth" channel due to a fundamental change in house prices through a representative-agent model with overlapping generations. In this model, "speculative" changes do produce changes in consumption. As a result, the observed housing wealth effect must be a result of redistribution effects between long and short housing or the collateralisability of housing wealth.

Macro evidence points to the collateralisability of housing wealth as one of the financial channels of monetary policy transmission. Case et al., (2001) find a strong correlation between aggregated house prices and consumption using national data for 14 countries and regional data in the US. However, the multiple nature of housing as an asset, consumption good, collateral and heirloom complicates this correlation making it difficult to establish causality. Aoki et al., (2004) explore this correlation through an adaptation of the financial accelerator model of Bernanke et al., (1999) and propose that it arises from the interconnectedness of households' balance sheets and housing markets resulting in lower borrowing constraints when house prices rise. Carroll et al., (2006) question the causal relationship between house prices and consumption and cast doubt over whether the relationship between aggregates may reflect omitted variables bias. Muellbauer et al., (1990) also draw from macro data to relate the UK consumer boom in the late 1980s to rising house prices recommending a reduction in homeownership subsidies to curve the imbalances in the national balance of payments. Contrarily, King (1990), in a discussion of the previous article, argues that higher future income expectations were the common driver of both consumption and house prices.

Following Buiter (2008), the distributional impact of housing prices only arises under

heterogeneous agents with different distributions of housing wealth and debt. The heterogeneity in consumption responses to house prices has also become a central topic in heterogeneous agent models (HAM) usually employed in macro analysis. For example, Kaplan et al., (2017) model movements in house prices to account for approximately half of volatility in non-durable expenditures. The construction of models with heterogeneous agents has opened up the possibility of accounting for varying asset distributions across household groups. For example, Cloyne et al., (2016) emphasised the differences in balance sheets that provoke differentiated responses to consumption across tenure groups, particularly outright owners and mortgagors. Bielecki et al., (2022) focus on the role of maturing assets, instead of balance sheets, in their study of the redistributive effects of monetary policy. However, their research does show that house price appreciation has in fact negative welfare effects over a majority of the population. Huo and Ríos-Rull (2016) contextualise the potential of balance sheet oscillation in consumption within the Great Recession and point to the limited capacity of households to acquire loans having been amplified by contractions in house prices.

These divergent views of the relationship between housing wealth and consumption are rooted not only in different theoretical views but also in different data sources and the use of different methodologies. While macroeconomists using time-series data find a strong correlation between house prices and consumption, the study of micro, household-level, datasets shows a more nuanced picture that challenges a straightforward causal relationship. Using UK micro data, Attanasio and Weber (1994) find that homeowners experiencing capital gains on their households do increase consumption with mortgagors increasing their consumption even further. Nevertheless, this is insufficient to explain the rise in consumption among younger households that they simulate as the result of an upward revision of permanent income that can result in a decline in aggregate saving rates.

Attanasio et al. (2011) confirm these findings in a further developed life-cycle model including uncertain processes for house prices and earnings. Li and Yao (2007) also use a life-cycle model with a detailed mortgage market to investigate how, although aggregate levels of welfare and consumption show little variation to attributable to house prices, the effects on individual households are more diverse. Their conclusions are coherent with Attanasio et al., (2011) and point to older homeowners benefiting more from housing appreciation. However, Attanasio et al., (2009) contradict the wealth channel, in opposition to Campbell and Cocco (2007) and find that it is in fact consumption among younger households that is related to rising housing prices and the macro correlation is a result of common causality. The approaches of these two papers are similar and rely on constructing pseudo-panel data after a series of cross-sections from the Family and Expenditure Survey (FES) [2]. However, the treatment of the data is different as Campbell and Cocco (2007) deflate current household expenditures and control for income.

More recently, the use of alternative identification strategies and panel data that detail the channels of this wealth effect have offered different results. Guren et al.,

[2] FES is the predecessor of LCFS, one of the two surveys used in this paper

(2018) use systematic differences in city-level exposure to house price dynamics as an instrument and find more nuanced MPCs of about 3% during the 1980s for the US. Also, at a geographic scale, county level, Mian et al., (2013) use credit card data to estimate one of the largest reductions in consumption resulting from declines in house prices, 0.6 to 0.8. While their model uncovers the distributional impact of the 2008 crisis, it does not isolate the role of house prices as it also includes non-tradeable labour income related to construction

Browning et al., (2013), using a large panel dataset from Denmark, differ from prior papers in their exploration of unanticipated house price shocks. It follows from PIH that it is only those price shocks that alter lifetime wealth expectations that would have an impact on consumption. To assess this, Browning et al., (2013) test for a unit root in house price processes and find that persistent house prices are stationary precluding large wealth effects and the subsequent impact on consumption. Their findings highlight the expenditure growth among credit-constrained households but fail to find evidence that older homeowners' consumption reacts to house price changes. The authors of this paper point to the use of panel data instead of pseudo-panel in the consistency of their results. Also using panel data for the UK merged with financial data Disney et al., (2010), find a very low, 0.01, Marginal Propensity to Consume (MPC) out of unanticipated shocks in house prices. This literature points to three main reasons for a negligible wealth effect: few households liquidating housing wealth, perception of non-permanent shocks and bequests motives. Engelhardt (1996) observes a 0.03 MPC and highlights the asymmetry between households experiencing losses that offsets those experiencing gains. Suari-Andreu (2021) challenges this evidence, while his results also show indistinguishable from zero coefficients for a pure wealth effect using panel data, he does not find evidence of asymmetry among Dutch households for the period 2004 to 2018 characterised by both declines and rises in house prices.

However, drawing also from panel data, Berger et al., (2018) find a relevant counterpoint to this literature using a model of incomplete markets for the US case. After finding an elasticity of consumption of 0.33, they follow the sufficient statistics approach (Chetty, 2009) to derive a formula that approximates consumption responses to permanent house price shocks as the marginal propensity to consume out of temporary income times the value of housing. The formula breaks down when households are underwater. According to Berger et al., (2018), this points to a time-varying elasticity that is heterogeneous among households. Paiella and Pistaferri (2017) contend that the difference lies between anticipated and unanticipated shocks. To explore this issue they combine Italian data on subjective expectations of asset returns and return realisation to distinguish between anticipated and unanticipated changes in wealth and find evidence of a small 0.03 wealth effect. In a recent paper, Caloia and Mastrogiacomo (2022) draw from this approach to investigate whether disregarding home improvement biases the MPC out of housing wealth. While the bias is zero since the small home improvements found do not alter home values, their analysis shows a reduction in savings of 0.027 for the Netherlands and 0.03 for Italy after unexpected changes in housing wealth. This paper is particularly apposite as it points to a lack of improvements and maintenance being value preserving with little evidence of home investments out of housing wealth.

2.3 Approach and Data

Building upon the previous section, this paper examines the relationship between MPC and house prices resulting from varying positions in the housing market. It explores the relation between household age and MPC in the context of rising house prices. According to the Permanent Income Hypothesis (PIH), this reaction can be attributed to younger generations, who are short in housing, reducing non-housing consumption in line with their future housing costs in response to price increases. In contrast, older households with larger equity proportions, long in housing, are expected to boost their consumption. Furthermore, this paper suggests examining energy efficiency in a similar light. Firstly, households in high energy-efficient dwellings would face increased housing costs to decrease energy expenses, either through retrofit or green premiums at purchase. A positive balance between these two expenditures would enable an increase in non-housing consumption, while a negative balance would lead to a reduction. Secondly, the interaction between energy efficiency and house prices could mutually reinforce each other. Households that are long in housing and live in energy-efficient homes would be expected to further increase their consumption when house prices rise, as they would not anticipate an increase in their future implicit housing costs. Conversely, younger households would counterbalance their energy efficiency premium against future housing costs.

In the UK, the lack of easily accessible longitudinal or administrative data at the household level complicates the study of the links between consumption and the built environment. To overcome this issue, this paper draws from a series of waves of two cross-sectional datasets collected through different surveys between 2009 and 2019. First, the English Housing Survey (EHS) gathers data on household characteristics and physical conditions, including energy efficiency. The EHS is a continuous national survey commissioned by the Department of Levelling Up, Housing and Communities. The survey has been running since 1967 and the latest available dataset, 2019, is accessible through the UK data service (MHCLG, 2022). Second, the Living Costs and Food Survey (LCFS), conducted across the UK, is the most relevant survey dealing with household spending and focusing on how the cost of living is reflected in household budgets. Although under different names, this survey has been running since 1957 and the latest available release at the time of writing, 2019, is accessible through the UK data service (ONS, 2022).

The main indicator of energy efficiency in the built environment are Energy Performance Certificates (EPCs). These were introduced in 2002 at EU level by the Energy Performance of Buildings Directive (EPBD). In the UK, EPCs were incorporated into national legislation in 2007 and progressively included as a mandatory requirement for the purchase and renting of real estate. To account for the gradual introduction of EPCs, this paper focuses on data from 2009 onwards, that is five waves of the EHS (77798 observations), which is released biennially, and five waves

TABLE 2.1 Energy Efficiency Rating Explanation

EHS Value	EPC	Efficiency	EPC Binary
2	A/B	Most Efficient	1
3	C		1
4	D		0
5	E		0
6	F		0
7	G	Least Efficient	0

of the LCFS (41648 observations) [3], released annually. These two surveys share a number of fields referring to inhabitants' household size, housing typology, tenure, rent, mortgage, household income, socio-economic classification, gas heating, and reference person's age. These common variables allow the prediction of Energy Efficiency for LCFS observations using the EHS. For example, Bridgeman (2020) conducts a merger of these two surveys through a random forest to create clusters of energy consumption profiles.

This paper uses a simplified version of this approach predicting Energy Efficiency in binary terms instead of a whole range of ordinal levels, see Table 1 for reference [4]. The prediction builds on a logistic binary model, see appendix A for detail, using 80% of the EHS data for "training" and 20% for prediction testing, achieving an accuracy of 76%, see appendix A for full regression and robustness checks. The cutting point on the binary prediction was 0.3, this threshold, lower than 0.5, did not compromise accuracy which points to an underprediction of Energy Efficiency. The final LCFS dataset included 38753 non-energy-efficient households and 2895 Energy-Efficient ones. The reduced numbers of energy-efficient homes point to issues of representativeness which could be related to the LCFS is not being designed to be representative of the overall housing stock. Ultimately, there seems to be a correlation between higher energy efficiency and lower overall consumption. Boxplots in Figure 5 show average non-housing consumption by age group subdivided by habitation in an energy-efficient house. Those in energy-efficient homes display lower consumption than those in not energy-efficient ones across all tenures and age groups.

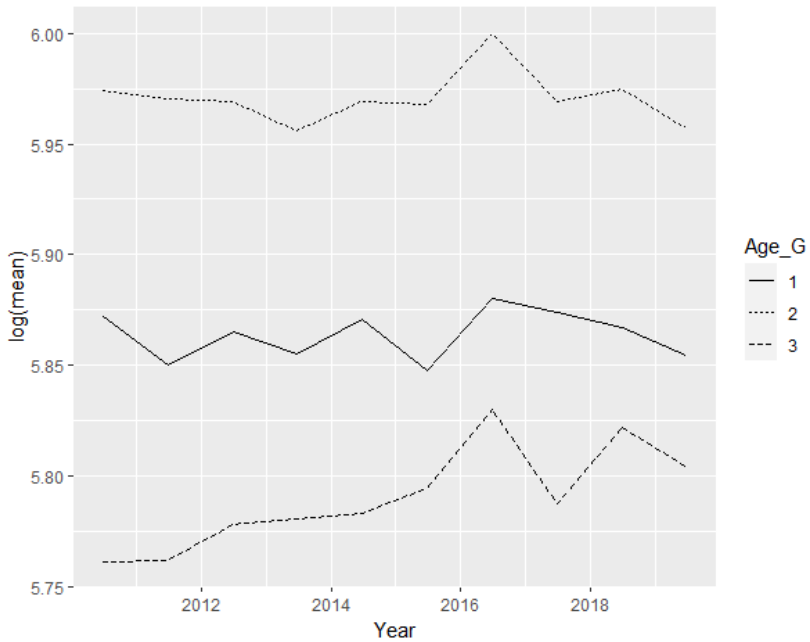
Following Attanasio et al., (2009) (from now on ABHL), non-housing consumption has been calculated by extracting housing costs, inclusive of energy, from total consumption and expressed in 2019 real prices using the Retail Price Index. LCFS microdata allows grouping consumption trends across three age groups, younger, under 35 years of age; middle–aged, 35 to 60 years; and older, above 60 years. Figure 1 shows that the upward trend in non-housing consumption seems to be only

[3] The LCFS survey uses weights to deal with outliers, since these weights are wave-based this paper has excluded the lowest and highest 10% in consumption deemed outliers

[4] The bundling of A, B and C ratings as energy efficient follows the objective of attaining a national average of C set out in 2020, see introduction

present in older households following the bouncing back of the real estate market post-2008. This contrasts with flat consumption in the two younger age groups, despite overall average consumption being lower for the oldest group. Older households' consumption also seems to correlate more strongly with stagnation in house prices in the last years of the 2010s. These trends seem to be replicated along tenure lines (see Figure 2), with owners outright and mortgagors displaying an apparent wealth effect, an increase in consumption in line with house prices; while private and social renters' non-housing consumption is not affected by house prices.

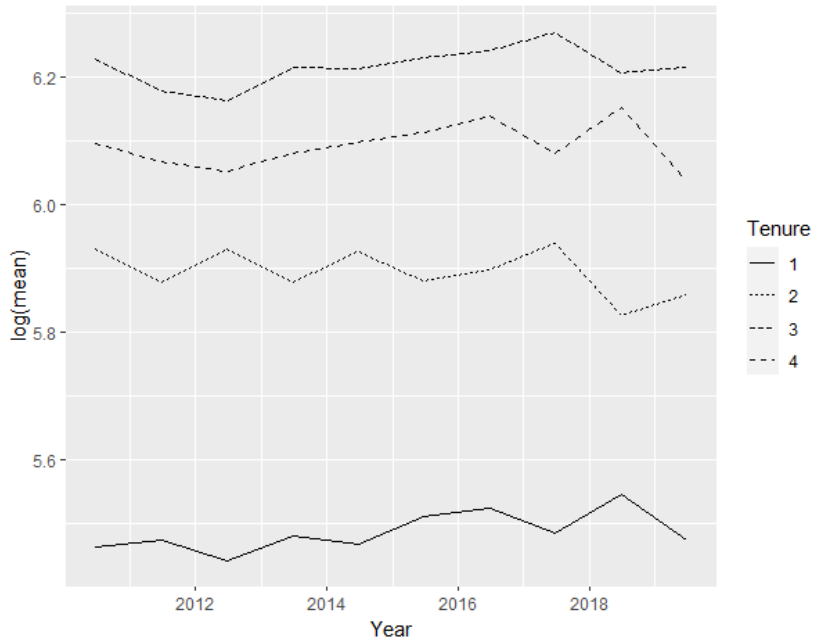
FIG. 2.1 Time Series Log Real Non-Housing Consumption in 2019 prices by Age Group (1,under 35; 2, 35-60; 3,65 or more)



Prepared by the author.

Figures 3 and 4, present the aggregate indicators of consumption, housing costs and house prices since 2009. In aggregate terms, consumption and house prices seem to move together, however, household consumption seems to have stagnated in 2014 to recover its path in 2016 while housing costs have continued on the same path even above overall consumption from 2016 to 2018. The goal of this paper is to analyse where these increases in aggregate consumption have accrued at the micro level, particularly after the subtraction of housing costs and attending to differences by age group, tenure and energy efficiency.

FIG. 2.2 Time Series log Deflated Non-Housing Consumption by Tenure (1, social renter; 2, private renter; 3, owner with a mortgage; 4 owner outright).

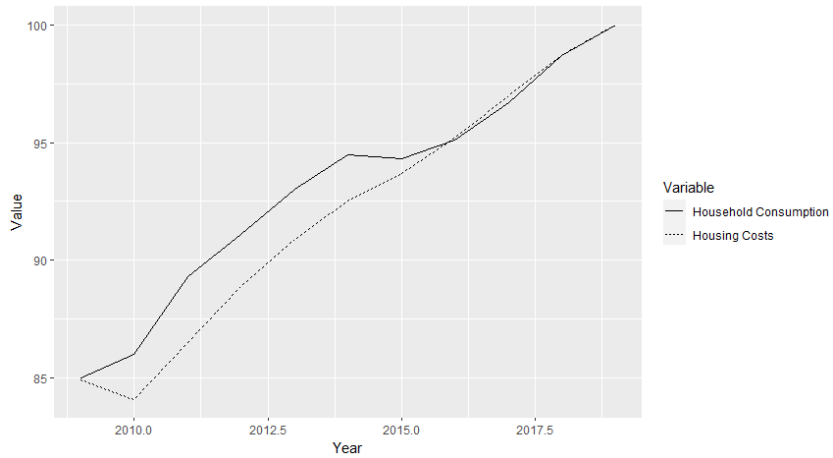


Source: Prepared by the author.

TABLE 2.2 Descriptive Statistics

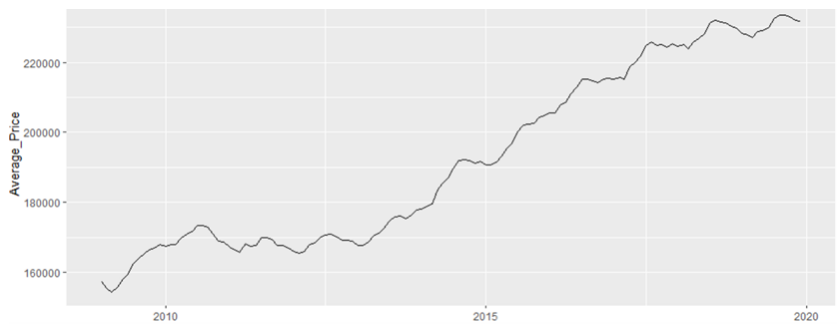
Statistic	N	Mean	St. Dev	Min	Max
Non-Housing Consumption	41,648	357.111	180.400	103.003	817.921
Cohort	41,648	6.872	3.310	1	14
Age	41,648	53.119	16.293	3	80
N Children < 2	41,648	0.066	0.259	0	3
N Children $2 \leq t < 5$	41,648	0.099	0.330	0	3
N Children $5 \leq t < 18$	41,648	0.383	0.785	0	7
N Adults	41,648	1.790	1.192	0	8

FIG. 2.3 Time Series Consumption and Housing Consumption. 100=2019. Source: ONS National Accounts. Prepared by the author.



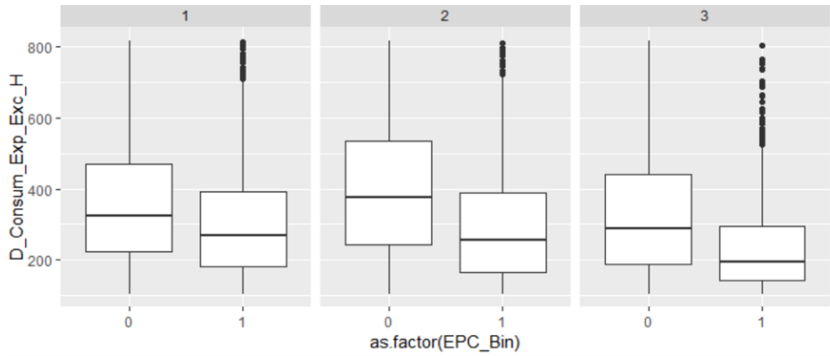
Source: Prepared by the author.

FIG. 2.4 Time Series Average House Prices.



Source: HM Land Registry. Prepared by the author.

FIG. 2.5 Real Non-Housing Consumption in 2019 prices by Age Group (1,under 35; 2, 35-60; 3,65 or more) and EPC status (1, energy-efficient; 0 not energy-efficient)



Source: Prepared by the author.

Following ABHL, a number of variables have also been included as controls to account for household particularities, namely the number of children and adults, reference person's age and educational attainment level, see Table 2. Finally, house price data was drawn from HM Land Registry which periodically releases regional data on average house prices based on transactions in a time-series format (HMLR, 2022) which allows to account for the existence of regional dynamics in real estate markets, see Figure 6.

2.4 Estimation Strategy

Prior research on the Marginal Propensity to Consume (MPC) has dealt with the lack of household-level longitudinal data through the use of pseudo-panels. Introduced by Deaton, (1985), this technique relies on the use of cohort dummies to produce panel data out of repeated cross-sections. Cohort are groups with fixed membership, usually built according to the age of the respondent. In this paper, cohorts were built attending to the date of birth of the Household Responsible Person (HRP). The oldest, cohort 1, comprises households where the HRP was born before 1934, cohort 2 was born between 1935 and 1939 and so on with the last cohort including those born after 1995.

While the use of age cohorts in the estimation of consumption over the lifecycle is a standard practice, this type of OLS estimation does not allow to control for

unobserved household effects (Aksoy et al., 2021). As a result, OLS estimations are likely to be biased unlike those resulting from estimations with household-level fixed effects (Mundlak, 1978). To account for some of these biases, this paper includes a number of controls presented in the data section. For instance, household composition, the number of children and adults, are likely to change over the lifecycle and have a direct impact on consumption. A polynomial for age and various measures of educational attainment, following ABHL. It is in fact the intersection of age and cohort features that allows accounting for any deterministic trends (Attanasio & Weber, 1994), like the macroeconomic environment. There is also no direct inclusion of income since in a life-cycle framework, permanent income is captured by the constants and unexpected income is included in the errors.

Over the ABHL baseline specification including the aforementioned controls, this paper adds a binary energy efficiency variable (Equation 1) (Table 1). The addition of energy efficiency as a control is a means of accounting for the premium of living in a home with enhanced fabric standards. Since the variable of housing costs excluded from consumption includes energy costs, this variable serves to account for the difference between energy savings and extra costs resulting from retrofitting or purchasing an energy-efficient home. As introduced in the data section, lower consumption among households in energy-efficient homes points to increased costs not being compensated by energy savings. This paper's main objective is to assess if the increases in house prices experienced in the 2010s have accrued in consumption across particular household types, namely age tenure and energy efficiency. The academic literature presents various hypotheses regarding the heterogeneous impact house prices can have on household consumption. From the tenure side, house prices accrue on homeowners' capital gains producing a wealth effect. This should be particularly noticeable in older homeowners long in housing. On the contrary, the absence of distinguishable coefficients across tenures and age groups would preclude the establishment of a causal relationship and point to the common causation between consumption and house prices.

Baseline:

$$\begin{aligned}\log(\text{NHConsumption}) = &\text{Constant} + \text{cohort}^{C} + f(\text{age}^{5}) + N_{\text{children}} + N_{\text{Adults}} \\ &+ D_{\text{2Adult}} + \text{Degree} + \text{Alevels} + \text{EPC} + \cdot\text{Age Groups} + \epsilon \end{aligned} \tag{2.1}$$

$$\text{Controls} = \text{cohort}^{C} + f(\text{age}^{5}) + N_{\text{children}} + N_{\text{Adults}} + D_{\text{2Adult}} + \text{Alevel} + \text{Degree}$$

Following ABHL, two strategies, both drawing from the time-series dataset on regional house prices presented above, are used to account for the effect of house prices on consumption. The first house price specification uses the log level of house prices by region over time interacted with age groups (Equation 3). The second house price specification (Equation 4) repeats equation 3 and adds EPC. To assess the role of differences in housing tenure, this same equation is also estimated with an interaction term including tenure instead of age groups (Equation 5).

Average House Price and Age Group:

$$\log(\text{NHConsumption}) = \text{Constant} + \text{Controls} + \text{Age Groups} + \log(\text{House Price}) + \log(\text{House Price}) \cdot \text{Age Groups} + \epsilon \quad (2.2)$$

Average House Price, EPC and Age Group:

$$\log(\text{NHConsumption}) = \text{Constant} + \text{Controls} + \text{EPC} + \text{Age Groups} + \log(\text{House Price}) + \log(\text{House Price}) \cdot \text{Age Groups} + \epsilon \quad (2.3)$$

Average House Price, EPC and Tenure:

$$\log(\text{NHConsumption}) = \text{Constant} + \text{Controls} + \text{EPC} + \text{Tenure} + \log(\text{House Price}) + \log(\text{House Price}) \cdot \text{Tenure} + \epsilon \quad (2.4)$$

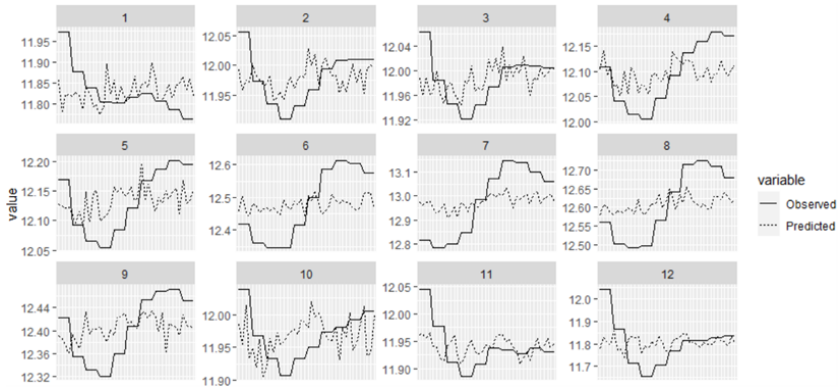
The second house price specification accounts for expected and unexpected changes in property prices. Since the LCFS does not include household-level expectations of house price increases, a model estimating house price variations was used to predict house prices (Equation 5). This model regresses Real Interest Rates, Regional Average Income, and regional dummies (Table 3), proxies expectations of house price changes understood as an ex-ante belief about the long-term trend of house prices. Similarly to ABHL, this simple model has a relatively high R2. Interestingly, the coefficient for household income is much lower in our specification than the one found by ABHL and Real Interest Rate seems to have a much larger impact. These differences point to an increased role of credit in determining house prices which seems coherent with current explanations of worsening housing affordability in the last decade (Meen & Whitehead, 2020). As Figure 6 shows, this model seems to be able to track house price changes in most regions with a degree of accuracy. The largest differences between predicted and observed prices are in London, Eastern and the South-East, where observed house prices are much above the level predicted by the model.

$$\log(\text{House Prices}) = \text{Constant} + \text{Real Interest} + \log(\text{Average Regional Household Income}) + \text{Regional Dummies} + \epsilon \quad (2.5)$$

TABLE 2.3 First Order Regression on House Prices

	Dependent variable:
	log(HP)
log(HI)	0.245***
	(0.040)
Real.Interest	0.011***
	(0.003)
Region 2	0.126***
	(0.017)
Region 3	0.137***
	(0.017)
Region 4	0.239***
	(0.017)
Region 5	0.278***
	(0.017)
Region 6	0.600***
	(0.018)
Region 7	1.067***
	(0.021)
Region 8	0.714***
	(0.020)
Region 9	0.543***
	(0.017)
Region 10	0.119***
	(0.017)
Region 11	0.089***
	(0.017)
Region 12	−0.027
	(0.016)
Constant	10.243***
	(0.264)
Observations	480
R^2	0.957
Adjusted R^2	0.956
Residual Std. Error	0.073 (df = 466)
F Statistic	807.023*** (df = 13; 466)
Note:	*p<0.1; **p<0.05; ***p<0.01

FIG. 2.6 Quarterly Predicted and Observed House Prices by Region(2009-2019) (1, North East;2 North West & Merseyside; 3, Yorkshire and the Humber; 4, East Midlands; 5, West Midlands; 6, Eastern; 7, London; 8, South East; 9, South West;10, Wales; 11, Scotland; 12, Northern Ireland)



Source: Prepared by the author

The last equation estimated, 6, draws from predictions from this first-stage model. These are subtracted from actual observations and the difference together with the predicted level are included in a three-way interaction with age groups and EPC (Equation 6). This specification aims at identifying any differences between expected and unexpected house price shocks across age groups and EPC. The objective of differentiating between energy-efficient and not energy-efficient housing aims to analyse whether house price appreciation impacts consumption differently albeit belonging to the same age group.

$$\begin{aligned}\log(\text{NHConsumption}) = {} & \text{Constant} + \text{Controls} + \text{EPC} + \text{Age Groups} \\ & + \log(\text{Predicted}) + \log(\text{Diff}) \\ & + \text{Age Groups} \cdot \log(\text{Predicted}) + \text{Age Groups} \cdot \log(\text{Diff}) \\ & + \text{EPC} \cdot \log(\text{Predicted}) + \text{EPC} \cdot \log(\text{Diff}) + \text{EPC} \cdot \text{Age Groups} \\ & + \text{Age Groups} \cdot \log(\text{Predicted}) \cdot \text{EPC} \\ & + \text{Age Groups} \cdot \log(\text{Diff}) \cdot \text{EPC} + \epsilon\end{aligned} \tag{2.6}$$

2.5 Findings and Limitations

The baseline model presented in Equation 1 (Table 4), (see Appendix B for full detail) offers an overview of the level of consumption explained by lifecycle patterns. The intersection of age variables and cohorts together with controls for household size and education are capable of tracing consumption across a majority of age groups (Figure 7). In contrast to ABHL, the use of a shorter time span, does increase volatility in consumption resulting from inconsistent membership. The results from the estimation of the baseline model also confirm the descriptive statistics and do find an overall negative effect of a positive EPC on consumption. This is coherent with what the literature on energy savings calls the pre and rebound effects (Sunikka-Blank & Galvin, 2012) where actual and expected consumption differ since households in low energy-efficient homes consume less energy than those in energy-efficient ones. Limitations of this particular finding are discussed more in-depth above, as drawbacks from the EPC imputation model, and below in the findings contextualisation.

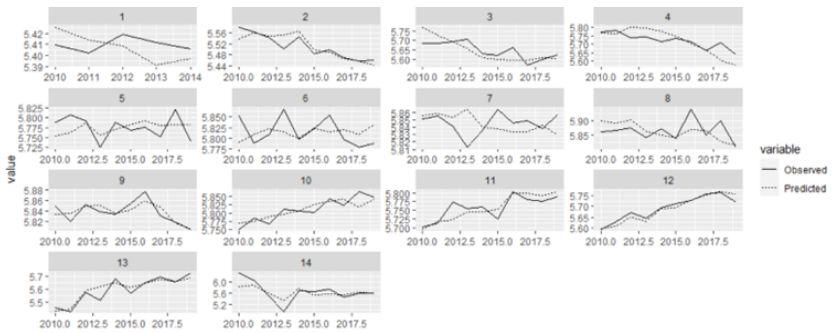
TABLE 2.4 Regression Results

	Dependent variable: log(Non-Housing Consumption)			
	EPC (1)	Age Groups(2)	EPC + Age Groups (3)	EPC + Tenure (4)
EPC_Bin1	−0.180***		−0.180***	−0.049***
	(0.010)		(0.010)	(0.010)
log(Average_Price)		0.002	0.028**	0.026
		(0.013)	(0.013)	(0.016)
Age_G2		0.556***	0.695***	
		(0.207)	(0.206)	
Age_G3		−1.011***	−0.722***	
		(0.210)	(0.210)	
log(Average_Price):(Age_G)2		−0.043**	−0.054***	
		(0.017)	(0.017)	
log(Average_Price):(Age_G)3		0.078***	0.055***	
		(0.017)	(0.017)	
(Tenure)2				0.263
				(0.269)
(Tenure)3				0.702***
				(0.241)
(Tenure)4				−0.132
				(0.238)
log(Average_Price):(Tenure)2				−0.010
				(0.022)
log(Average_Price):(Tenure)3				−0.036*
				(0.020)
log(Average_Price):(Tenure)4				0.039**
				(0.020)
Constant	6.544***	5.270***	4.967***	6.417***
	(0.410)	(0.503)	(0.502)	(0.444)
AIC	57404.64	57644.77	57297.41	55336.3
Observations	41,646	41,646	41,646	41,646

R^2	0.178	0.174	0.181	0.218
Adjusted R^2	0.178	0.173	0.180	0.218
Residual Std. Error	0.482 (df = 41623)	0.483 (df = 41619)	0.481 (df = 41618)	0.470 (df = 41616)
F Statistic	410.240*** (df = 22; 41623)	336.266*** (df = 26; 41619)	339.517*** (df = 27; 41618)	400.696*** (df = 29; 41616)

Note: *p<0.1; **p<0.05; ***p<0.01

FIG. 2.7 Log Yearly Predicted and Observed Deflated Consumption Baseline Model Excluding Housing costs in logs by Age Cohort (1 Oldest - 14 Youngest)



Source: Prepared by the author.

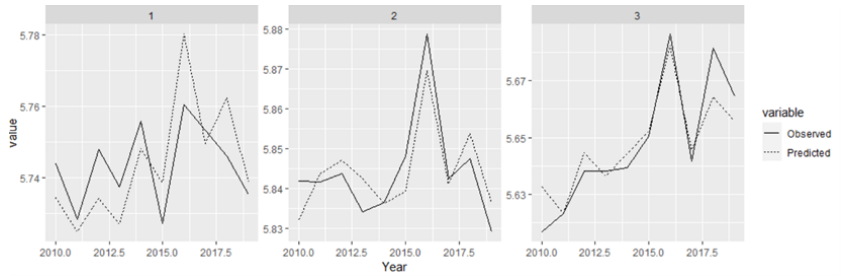
The first house price specification, Equation 3, summarised in Table 4, builds on regional house prices (log average house price) included in interactions with each group (Age G). The estimates point to a positive effect of house prices on consumption when interacted with age groups. Older households present a 0.078 estimate with a small error (0.017) while there is a negative effect for middle-aged ones (-0.043), the estimate for younger households is included in the constant. Once we incorporate EPC as a control, Equation 4, these differences are mitigated, showing a (0.055) estimate for older households with a small error (0.017) while there is a negative effect for middle-aged ones (-0.054). Albeit these effects are small, they are in contrast with those found by ABHL. In their case, the coefficients across age groups are similar and point to the co-movement of house prices and consumption. On the contrary, these estimates differ by age group pointing to a positive wealth effect of rising house prices on consumption for older households, "long" in housing, more likely to own and have larger amounts of equity in their homes. Meanwhile, middle-aged households experienced a negative impact of house price increases in consumption. These households are more often “short” in housing, that is, just entered a mortgage or are likely to need to move into larger properties as their household size expands. When it comes to younger households, their estimate seems

to be in between the two groups which points to co-movement with housing prices. These findings are more in line with those of Campbell and Cocco (2007) despite not including income as a control. The dissimilarities in the coefficients also seem to support the findings of Engelhardt, (1996) of a small MPC that is in fact compensated by different reactions across groups.

TABLE 2.5 Regression Results Predicted vs Observed House Prices

	log(Non-Housing Consumption)
EPC_Bin	−0.098*** (0.015)
Predicted	0.007 (0.014)
(Age_G)2	0.072 (0.219)
(Age_G)3	−0.140 (0.218)
Diff_Pred_Obvs	0.058 (0.071)
Predicted:(Age_G)2	−0.003 (0.018)
Predicted:(Age_G)3	0.009 (0.018)
(Age_G)2:Diff_Pred_Obvs	0.004 (0.091)
(Age_G)3:Diff_Pred_Obvs	−0.128 (0.090)
EPC_Bin1:Diff_Pred_Obvs	−0.464** (0.218)
EPC_Bin1:(Age_G)2	−0.109*** (0.022)
EPC_Bin1:(Age_G)3	−0.159*** (0.024)
EPC_Bin1:(Age_G)2:Diff_Pred_Obvs	0.592* (0.327)
EPC_Bin1:(Age_G)3:Diff_Pred_Obvs	0.764** (0.353)
Constant	5.180*** (0.575)
AIC	57306.52
Observations	41,646
R^2	0.181
Adjusted R^2	0.180
Residual Std. Error	0.481 (df = 41606)
F Statistic	235.448*** (df = 39; 41606)
Note:	*p<0.1; **p<0.05; ***p<0.01

FIG. 2.8 Log Yearly Predicted and Observed Deflated Consumption Average House Price Model in logs by Age Group (1, under 35; 2, 35-60; 3,65 or more).



Source: Prepared by the author.

The specification resulting from equation 5 substitutes Age Groups with Tenure (1, social renter; 2, private renter; 3, owner with a mortgage; 4 owner outright) also interacted with log Average House Prices. The estimates between owner with a mortgage (-0.036) and owner outright (0.039) have the same signs as those of age groups and reinforce the hypothesis of a moderate wealth effect whereby households owning outright do consume more as house prices increase, while mortgagors are in fact negatively affected by house prices, as entry costs in mortgages go up and the perspective of upsizing becomes presumably more costly. The AIC is substantially lower in the Tenure specification pointing to differences in asset positions related to tenure being more relevant than age in explaining consumption patterns. These findings are consistent with those in the model presented by Berger et al., (2018) for the US, which shows low consumption response for renters and mortgagors and larger responses for outright owners.

Interpreting these results in the manner of ABHL, the existence of different coefficients for age groups and tenures points to the breaking down of co-movement between house prices and consumption. In the last ten years, this relationship seems to only hold strongly for older households pointing to a moderate wealth effect for older households. Despite the inclusion of controls for life-cycle variables through age, this correlation between older households' consumption and house price appreciation could also be a result of common trajectories between house prices and other types of capital gains related to the appreciation of other more liquid financial assets. While larger coefficients for older groups point to wealth effects, larger coefficients for younger groups could be associated with an increase in economic activity resulting in higher expected future income for those relying on the labour market. In the estimates, this only seems to be the case for younger cohorts. These could reinforce a nuanced co-movement argument for younger households. Encountering such different estimates to those in ABHL may point to the establishment of different consumption patterns and expected incomes after the GFC. This is reinforced by a lower R2 (0.178-0.218) than in a similar specification in ABHL (0.51-0.52).

In the second price specification, outlined in Equation 6, house prices are divided into two variables. The first variable represents predicted prices, as forecasted by the house price model specified in the methodology section (Figure 6). The second variable entails the discrepancy between the predicted and observed house prices (as per Equation 6). These variables are then interacted with age groups and the Energy Performance Certificate (EPC) binary indicator (see Table 5 and Appendix C for detailed estimates). Unexpected house price increases appear to negatively impact consumption among households in energy-efficient homes. However, an interaction with age suggests a positive effect for households within the older age bracket. In other words, unanticipated house price increases seem to positively influence consumption among older households residing in energy-efficient homes. While the error in this coefficient is substantial, the magnitude appears to be significantly larger than those previously encountered in the other regressions (0.7). This sizable positive estimate could indicate a larger wealth effect associated with house price appreciation in energy-efficient homes, particularly among older households. This suggests a heterogeneous accrual of property premiums dependent on household age. Older households, being long in housing, would also be better poised to benefit from superior quality homes since they do not need to account for upsizing or future investments. Hence, they increase their consumption in line with house prices. This also seems to be the case for middle-aged households in energy-efficient homes, albeit to a lesser extent. A complementary specification included in Appendix C further explores this possibility by interacting tenure and EPC. However, the estimates are not statistically significant. Consequently, these regression results should be interpreted cautiously as evidence of a heterogeneous accrual of property premiums across different age groups but not tenures.

The lack of any significant coefficients between predicted house prices and consumption points to the de-coupling of earnings and house prices since predicted house prices are a function of regional average household income and interest rates. There are two relevant limitations of these findings. First, there is a lack of actual estimates of house price value collected via surveys such as the ones used by Caloia and Mastrogiacomo (2022) for Italy and the Netherlands. The second limitation relates to the prediction of EPC certificates and how LCFS may not be representative when it comes to built-environment dimensions, as a result, the negative estimate for consumption in energy-efficient properties should be interpreted with caution. Furthermore, one of the main limitations of the current approach is the lack of panel data which allows to compare pooled OLS results, biased due to unobservables; and estimates from a fixed effects model that would overcome these biases, as presented in the methodology section. The divergence between the estimates obtained and those encountered in the literature relates to the use of actual panel data and specifications using fixed effects, i.e. (Disney et al., 2010) (Suari-Andreu, 2021). Finally, more granular data, capturing location, could allow the use of an IV building on differential exposure to house price and retail employment shocks as in Guren et al., (2018).

2.6 Discussion and Policy Relevance

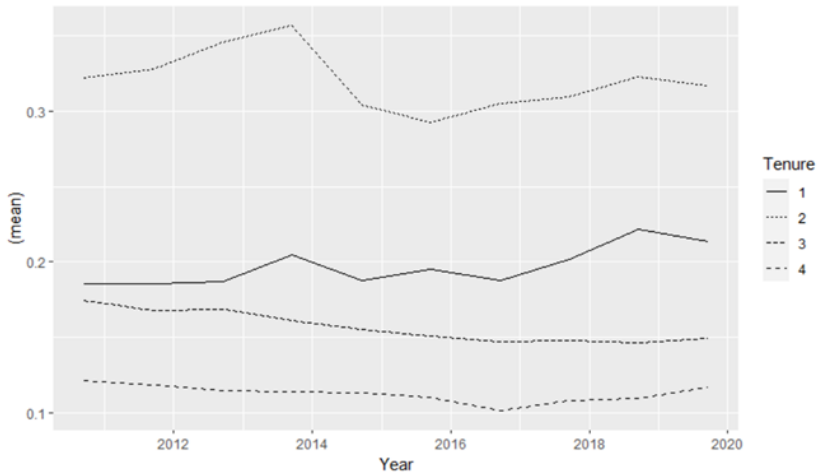
This paper has analysed heterogeneous consumption reactions to house price increases across households with varying positions in the housing market, tenure and energy efficiency levels. Incorporating heterogeneous consumption reactions allows for a more comprehensive understanding of the distributional implications of changes in the housing market. These findings provide insight into how different households are affected by large-scale changes in the housing market and can inform targeted policy interventions to address energy efficiency and wealth disparities.

Noticeably, from a tenure perspective, the regression presented above only offers statistically significant results for homeowners with a contrast between outright and owners with a mortgage. As shown in Figure 9, these two groups are the ones whose housing costs to income ratio is the lowest and has remained the most stable or even decreased in the last decade. On the contrary, the proportion of income taken up by housing has increased for renters. The finding of a wealth effect among older homeowners is coherent with these observations since older households are more likely to own outright or have larger amounts of equity and are hedged against increases in house prices. Although the increase in housing costs for the youngest group is more nuanced than among private renters, differences in housing costs translate to age groups. This stems from the average age of renters having slowly increased over the last 10 years, Figure 10. While age profiles have remained fairly constant in the other age groups, the average age of renters has increased which points to a different life-cycle consumption pattern for younger generations. This raises questions about how further property appreciation resulting from energy improvements may affect younger households without assets.

Establishing a dialogue between the literature on consumption and house prices, together with the hedonic pricing literature on energy efficiency is particularly pertinent for the design of policies incentivising retrofit. Although there are disputes regarding the size of the premium, it has been well-established that higher energy efficiency increases property values both in rental and owner-occupation markets, see Fuerst et al., (2015), Fuerst et al., (2020). According to this paper's findings, property value increases are likely to accrue in the consumption of older households, while they may further reduce the chances of acquiring property for first-time buyers or upscaling for households with low equity. While this paper does not find a relationship between the consumption of renters and house prices, the existence of a negative relationship between owners with a mortgage and house prices may point to increased leveraging and the foregoing of consumption for deposit savings. Further research on the consumption patterns of households constrained by large housing costs may help elucidate the distributional impact of EPC improvements.

Current policies incentivising housing retrofits rely on the one hand, on the subsidisation of a proportion of retrofit costs. First, the Green Homes Local Authority Delivery Scheme offered £0.5 billion in 2020-21 for which local authorities could bid

FIG. 2.9 Time-Series Average Ratio of Housing Costs to Income by Tenure (1, social renter; 2, private renter; 3, owner with a mortgage; 4 owner outright).



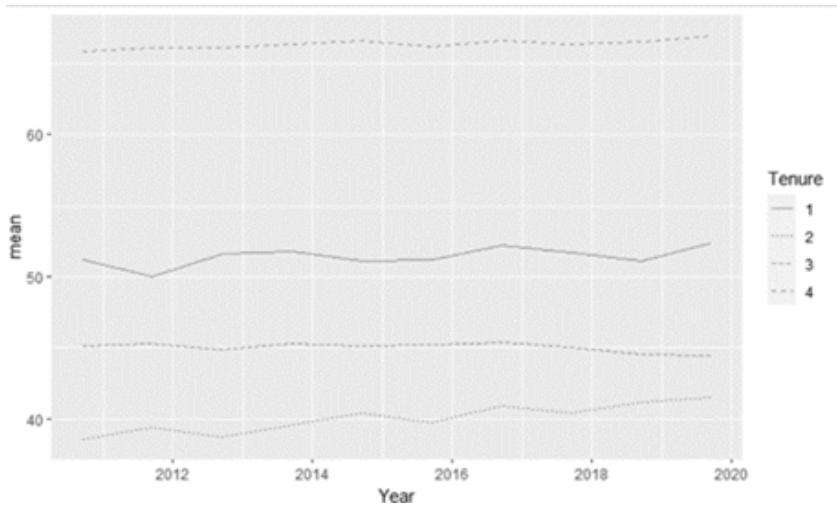
Source: Prepared by the author.

to fund improvements in energy efficiency. Funding could go up to £10,000 in the case of homeowners and £5,000 per property in the case of private rental with landlords contributing at least a 1/3 of the costs (BEIS, 2020). Also, the Green Homes Grant Voucher Scheme specifically targeted the retrofit of owner-occupied homes. However, according to the National Audit Office (NAO, 2021), payment delays and time constraints in fund allocation prevented it from reaching its goals both on carbon reduction and job creation. On the other hand, the government has also introduced Minimum Energy Performance standards (MEPS) which precluded the granting and continuation of tenancies of properties with an EPC below F and G. According to Ferentinos et al. (2021), this policy decreased values in affected properties by about £5,000 to £9,000 relative to unaffected ones.

Heterogenous reactions to house price increases, resulting from the unequal capitalisation of energy efficiency, become relevant when evaluating retrofit policy options. As a result of these heterogenous estimates, older households seem better poised to benefit from the value uplift resulting from retrofit than younger ones. This observation is backed by recent OECD data pointing out that housing wealth is increasingly concentrated in high-income and high-wealth households (Causa et al., 2019). It follows that subsidies targeting the worst-performing stock regardless of its occupants' socioeconomic characteristics can reinforce the concentration of wealth since older households tend to live in the least energy-efficient section of the stock, see Figure 11. This type of housing quality-centred transition subsidies would be regressive, lowering housing costs for the already wealthy outright homeowners. Conversely, the introduction of MEPS, instead of subsidies, could serve as a redistributive mechanism triggering investment from these same older households

without over-subsidisation.

FIG. 2.10 Time-Series Average Age By Tenure (1, social renter; 2, private renter; 3, owner with a mortgage; 4 owner outright).

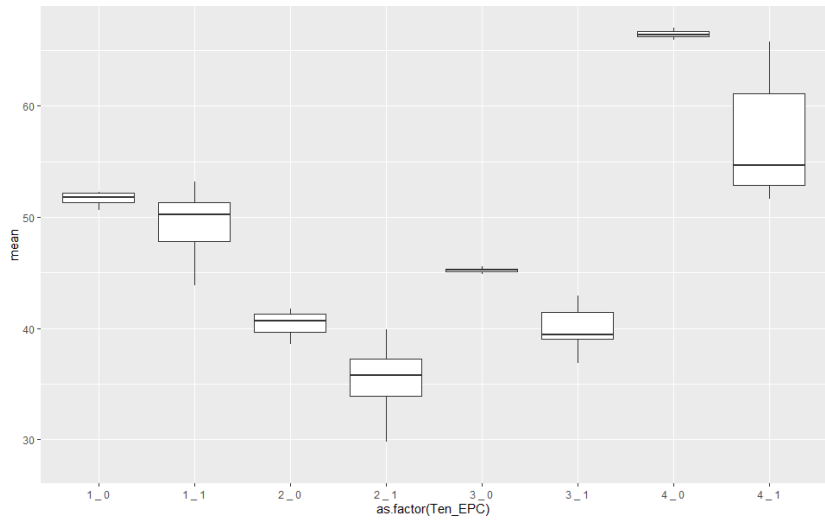


Source: Prepared by the author.

Taxation is another possible path towards a redistributive incentivisation of housing retrofit. Muellbauer (2018) introduced the idea of a Green Land Tax composed of two elements, one based on built-up surface and another one on unoccupied land. Energy-efficient buildings would pay the same tax as unoccupied land while energy-inefficient ones would pay a proportional increase by energy use. Such tax would create incentives to retrofit and improve the financial viability of increasing densities as the tax burden on built-up surface could be shared by different households in multiple occupation buildings but concentrated in one in the case of single-family dwellings. In this regard, the study of policies such as mortgage interest deduction has pointed out how the lack of adequate taxation leads to the overconsumption of owner-occupied housing and increases in house prices (Fatica & Prammer, 2018) (Poterba, 1984). On the one hand, targeting grants to households could incentivise retrofit among low-income homeowners for whom the impact of increased costs could pose affordability problems. On the other hand, increased taxation of energy-inefficient homes could help redistribute housing wealth toward younger homeowners in the most energy-efficient proportions of the stock and incentivise retrofit through increasing housing costs for house-wealthy households. However, the political feasibility of these drastic policy changes remains questionable.

In short, the overall conceptualisation of the energy transition in housing as a technological issue related to energy savings and upgrading costs does not capture the impact that widespread property appreciation can have over consumption and asset distribution. Incorporating a distributional analysis of house price appreciation

FIG. 2.11 Average age by EPC Binary (1=Efficient) Tenure (1, social renter; 2, private renter; 3, owner with a mortgage; 4 owner outright).



Source: Prepared by the author.

in policy design has the potential to mitigate the further eschewing of housing wealth toward older asset–wealthy households at the expense of younger ones.

2.7 Conclusion

Drawing from the economic literature on house prices and consumption, this paper aimed to critically discuss the existence of a wealth effect relating property appreciation and consumption in the UK. The regression findings show that older households and outright owners have increased their consumption in line with property prices. Conversely, middle-aged households and owners with a mortgage have in fact experienced a negative effect of house price increases on consumption. Younger households seem to increase their consumption less than older ones but are still partially in line with house prices. This points to the existence of a certain wealth effect for older households and outright owners, while younger households' consumption seems to co-move with house price increases, probably due to common causation. The negative coefficient for energy efficiency over consumption once

excluding housing and energy costs, also suggests that households in energy-efficient homes do experience higher housing costs not compensated by energy savings. When interacted with house price and age, energy efficiency seems to have a more positive effect on older households' consumption. Ultimately, this points to differentiated distributional impacts of house price appreciation over age groups. This consideration is usually absent from the design of housing retrofit incentives. While grants directly increase the viability of retrofit, this may result in regressive impacts. Alternatively, forms of green land value tax as proposed by Muellbauer, (2018) and MEPS have the potential to place incentives on property owners with large assets capable of mobilising private investment to improve energy efficiency.

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3 Unequal Welfare Rewards to Decarbonisation

a diff-in-diff approach to measuring housing costs across tenures

Abstract[1]

The large-scale transformation of the housing stock towards net zero energy has mobilised public and private investment alike and is expected to gain momentum in the coming decades. Studies have investigated the impact of decarbonisation on rents and property. However, less is known about the impact decarbonisation has on housing costs, particularly across tenures as well as the impacts on the welfare of the residents. These issues are relevant in the Dutch context as housing unaffordability has distinct impacts across homeowners and renters. This paper proposes a matching and diff-in-diff approach to tracing the impact of decarbonisation on housing costs across tenures. Matching allows to control for different levels of housing and energy consumption before the intervention while the diff-in-diff approach obtains robust estimates of the impact decarbonisation has on total housing costs. The main empirical source is registry data between 2018 and 2021 structured in panel form. The results identify a different percentage reduction in housing costs across tenures. Outright owners present the largest percentage reduction in total housing costs, while the larger reductions in absolute terms are observed among mortgagors. The lowest reductions in absolute terms are among private renters, while social renters fall in between these categories. Finally, a welfare analysis is conducted to discuss how the capitalisation of cost savings may influence welfare across tenures, highlighting a potential advantage for homeowners over renters.

[1] This chapter received a revise and resubmit decision by the journal Urban Studies and is currently undergoing revisions in response to the reviewers' comments.

3.1 Introduction

Across the EU, the large-scale transformation of the housing stock to reduce energy demand and achieve net-zero energy has become central in policymaking. The push for higher energy efficiency has been driven directly by the Energy Efficiency (EU/2023/1791) and Energy Performance of Buildings Directives (EU/2024/1275) but also indirectly through disclosure requirements for financial institutions and investors through the Taxonomy Regulation (EU) 2019/2088 and the Sustainability-Related Disclosure Regulation 2022/1288. As a result, decarbonisation is reshaping housing costs and property markets across the continent. On the one hand, higher energy efficiency is well-documented to both increase property values and command a rental premium (Aydin et al., 2020) (Fuerst et al., 2020). On the other hand, properties lagging in quality, such as those non-compliant with minimum energy performance standards (MEPS) in the UK, have seen a decline in value (Ferentinos et al., 2021).

The effects of environmental policies targeting the reduction of energy consumption on household living costs have been less straightforward and sometimes proven regressive. For example, the Dutch carbon pricing scheme, designed to reduce energy consumption, has disproportionately impacted lower-income groups (Maier & Ricci, 2022). Similarly, the planned expansion of the EU's Emissions Trading Scheme to include buildings is anticipated to have regressive consequences for households across Europe (Maier et al., 2024). This is because lower-income households, which spend a larger share of their income on consumption, bear a heavier tax burden. The impact is further amplified by their higher spending on carbon-intensive goods, such as residential energy.

When it comes to housing renovation, researchers have often focused on energy savings as the main component of housing costs affected by changes in housing energy efficiency. For example, in a recent study of renovation in the Netherlands, Kattenberg et al., (2023) find that increased housing insulation reduces gas consumption by about 20%, on average, both for owner-occupied and rental homes. Brom et al., (2019) also explore how household composition and income play a role in the reduction of energy consumption post-renovation in the social housing sector. In short, determinants of energy savings have been explored.

However, much less is known about how new cleavages regarding energy efficiency may exacerbate historical housing inequalities, particularly across tenures, and how the energy efficiency measures affect the welfare of residents, based on the existing cleavages between owners of dwellings and renters (Arundel & Ronald, 2021). The private rental sector has been characterised as a vehicle for wealth accumulation for landlords, typically high-income households, while putting a strain on private renters (Hochstenbach, 2023). This marked division between renters and owners has led to growing interest in the distributional impacts of housing renovation. Traditional measures of housing affordability typically use a static ratio of housing costs to

income (Haffner & Hulse, 2021). Although variations of this ratio exist, incorporating factors such as transport costs and energy (Haffner & Boumeester, 2015), these metrics remain point-in-time statistics and offer limited control options on variations regarding housing and energy consumption. Consequently, they fall short in assessing the impact of decarbonisation on housing costs across households with evolving and heterogeneous characteristics, such as tenure and energy efficiency.

In response, researchers have drawn from micro datasets to introduce more nuanced measures of the relation between housing consumption and income. Ben-Shahar et al., (2019) proposed a new affordability measure that draws from micro-data to adjust housing consumption by certain minimum standards. This consumption-adjusted approach indicates an even sharper increase in housing cost burdens. Longitudinal data has also been used to explore the drivers of housing costs, revealing socio-economic differences between households with temporary versus persistent affordability issues (Baker et al., 2015). These studies highlight that longitudinal data provides deeper insights into changing housing costs patterns compared to point-in-time measures, especially in relation to the influence of income and tenure choices (Kim & Kang, 2024). In policy evaluation, quasi-experimental designs such as difference-in-difference methods, have also leveraged longitudinal data to assess, for example, policy impacts on rent control, affordability, and related health outcomes across different housing tenures (Angrist & Pischke, 2009; Kholodilin, 2024; Pollack et al., 2010).

Building on longitudinal models and quasi-experimental economics, this paper employs a difference-in-differences (diff-in-diff) approach to analyze changes in housing costs across tenures. This approach builds on the comparison of housing costs from decarbonised households before and after decarbonisation against a control group. The primary objective is to answer the question: how does decarbonisation impact housing costs across different tenures? As highlighted in the literature, tenure differences are a critical driver of housing inequalities. The Dutch context provides an ideal setting to investigate these issues due to the persistent unaffordability and pronounced tenure inequalities, as well as decarbonisation, through the reduction of domestic gas consumption (Rijksoverheid, 2019), being a national priority. Moreover, the availability of comprehensive registry data, encompassing all households in the Netherlands along with a wide range of social and economic variables, allows for the robust matching of decarbonised households to an appropriate control group. This approach facilitates tracking the impact of decarbonisation on housing costs over time—a crucial concern as housing costs are expected to undergo significant transformations in the coming decades. Ultimately, by examining how decarbonisation affects housing costs through the lens of longitudinal data, this paper advances a dynamic, over time, and comparative, across tenures, approach to housing costs.

In the next section, this paper delves into different approaches to measuring housing costs and posits the need to identify and assess changes in housing costs as decarbonisation progresses. The third section presents the methodology which draws mostly from quasi-experimental designs as well as introducing the dataset and corresponding preprocessing approach. The fourth section presents the main

research results and discusses key limitations, while the fifth focuses on the welfare effects for households and discusses policy-relevant insights. The sixth section concludes.

3.2 Literature Review

3.2.1 Unequal housing consumption and costs

This section introduces contemporary debates on housing costs and their implications for household consumption. Housing consumption has traditionally been analyzed using the ratio of housing costs to income (Quigley & Raphael, 2004; Haffner & Boumeester, 2015). This ratio, which often uses a 0.4 threshold as a marker of housing burden (OECD, 2021), has been criticised for its limitations. On one side, it fails to account for changes in housing's underlying value as an asset, which affects the real cost of homeownership. In response, Poterba (1984) introduced the concept of user costs, shifting the focus from cash outflows to asset appreciation. This model has gained traction in studies examining housing inequality, asset accumulation, and homeownership taxation (Poterba, 1984; Fatica & Prammer, 2018; Haffner & Heylen, 2011; Fernández et al., 2024). By focusing on the long-term costs of owning a home, this approach provides a comprehensive understanding of the financial impact of homeownership beyond immediate expenditures.

Moreover, the housing costs to income ratio has been critiqued for accepting the existing income distribution without considering the consumption of non-housing goods. Whitehead (1991) emphasises this limitation, while the residual income approach, proposed by Stone (2006), suggests that housing costs should leave sufficient income for other essential expenditures. In parallel, economists have explored the relationship between non-housing consumption and housing costs using the Marginal Propensity to Consume (MPC). At the macro level, studies have consistently identified a correlation between housing costs and consumption (Case et al., 2001; Mian & Sufi, 2011). However, micro-level analyses reveal a more nuanced relationship that varies depending on tenure (Attanasio et al., 2011; Paiella & Pistaferri, 2017) and in some cases question whether a relationship exists at all (Suari-Andreu, 2021).

A focus on housing consumption adds further complexity to discussions on housing costs, as consumption patterns vary significantly between income groups. Lower-income households tend to under-consume housing, while higher-income households may over-consume which poses issues when assessing whether causes

of housing unaffordability lie with low incomes or high housing costs (Thalmann, 1999). Expanding on Thalmann's (1999) approach to address these disparities, Ben-Shahar et al. (2019) propose a consumption-adjusted approach to housing costs. This method uses regression analyses to impute average housing consumption levels across households, revealing inequalities in housing costs that are often hidden by differences in consumption patterns. Their work builds on earlier research into housing inequality (Ben-Shahar & Warszawski, 2016), with housing consumption defined through the number of rooms. This method highlights how households with similar income levels may experience very different housing costs based on their consumption habits. Further historical research supports this focus on housing consumption. Eichholtz et al. (2022) show that improvements in housing quality and size throughout history were often accompanied by growing disparities in housing consumption. They argue that this trend continued until the 20th century, when rent controls and other policies helped reduce inequalities. These findings are particularly relevant as they illustrate the long-term relationship between housing consumption, quality, and costs, and how policies can shift these dynamics.

Beyond size, building standards were in fact the first housing domain to be a foci of government intervention through minimum safety and health requirements. According to Whitehead (1991), standards impact housing costs indirectly by defining a minimum level of housing quality for all households. Currently, in the face of climate change and the energy crisis, energy efficiency standards have gained relevance as governments around the world incentivise the renovation of the housing stock, see (Economidou et al., 2020) for a review of EU policies. Enhancing standards has also been shown to reduce the value of non-compliant units (Ferentinos et al., 2021) and increase that of compliant ones (Aydin et al., 2020). Simulation studies have also showed that policy choices regarding taxation of subsidisation of energy efficiency are likely to produce differential impacts on the user costs of housing costs as owners enjoy property appreciation or face wealth loses (Fernández et al., 2024).

3.2.2 Energy transition studies

This section presents first studies on energy efficiency to explore the relationship between housing standards and costs. Second, the focus becomes more methodological referencing works that draw from longitudinal datasets to study housing costs and identifies the gap this study addresses.

Empirical studies on the impact of housing renovation have tended to focus on the reduction of energy costs. For example, Metcalf and Hassett (1999) investigate the return of insulation measures through energy bills data and point to a performance gap between expected and actual energy consumption deterring household investment. Allcott & Greenstone (2024) also use energy savings data and the mismatch between predictions and actual savings to argue for the introduction of energy taxation instead of subsidisation to achieve social optimums. Similar studies

disentangle the impact different strategies may have on final energy consumption (Hong et al., 2006; Liang et al., 2018). In the Netherlands, Kattenberg et al. (2023) find that improving housing insulation leads to an average reduction in gas usage of approximately 20% for both owner-occupied and rental properties. Also in the Netherlands, Brom et al. (2019) has drawn from a large panel dataset to investigate the drivers of heterogenous reductions in energy savings among social housing tenants pointing out that income and household composition play and important role in energy savings. These studies usually draw conclusions from registry-level datasets regarding particular projects. As a result, the identification of a particular environmental intervention is particularly robust, however the broader impact decarbonisation may be having over housing costs inequalities remains underexplored (Burlinson et al., 2018).

In contrast to studies focused on energy consumption, research on housing costs and affordability tends to rely on survey datasets that are representative of larger populations. Micro datasets have also opened up questions regarding the drivers of housing affordability. For instance, Baker et al. (2015) also leveraged this type of data to investigate the socioeconomic differences between households experiencing occasional versus persistent housing affordability issues. They argue that longitudinal data offers more insight about housing unaffordability patterns than point-in-time measures which do not account for evolving patterns among those experiencing housing unaffordability. More recently, using US panel data, Kang (2023) found that the severity of a household's housing instability—characterised by frequent, involuntary moves or living in unaffordable or substandard conditions—tends to extend the duration of the instability over time. Kim & Kang (2024) have also drawn from longitudinal data to show how the interlock of housing income and tenure choices heighten the probability of experiencing housing unaffordability. These papers emphasise the importance of understanding how housing costs are unequally distributed, with lower-income households often spending a significantly higher proportion of their income on housing.

The unequal burden of housing costs is particularly acute for renters and lower-income households, who may lack access to energy efficiency improvements due to either financial constraints or landlord decisions. The gap between the narrow focus on energy savings in renovation studies and the broader trends in housing affordability highlighted by longitudinal research creates a crucial area for further investigation. The small-scale data typically employed to assess the efficacy of physical interventions do not account for the more complex and uneven impacts of energy efficiency on overall housing costs, particularly when it comes to low-income households that already face disproportionate housing costs. Also, the performance gap, for example, (Metcalf & Hassett, 1999) identified in energy consumption studies suggests that the promised cost reductions from energy-efficient renovations may not materialise as expected, raising concerns about whether these improvements translate into meaningful reductions in overall housing costs. Particularly, studies like Brom et al. (2019) and Burlinson et al. (2018) suggest, the distribution of benefits from energy efficiency measures is often uneven, with social housing tenants and lower-income groups being left behind. As noted by Coulter et al. (2020), longitudinal analysis is crucial for tracking these trends over time, allowing for a

more nuanced understanding of how housing costs evolve in response to policy interventions.

This paper, therefore, proposes to examine housing costs across various tenures using a micro-level approach to explore the broader impact that decarbonisation is having on housing costs in different tenure types. By employing an econometric model grounded in program evaluation research and applied to a comprehensive registry dataset, this research delves into the distributional effects of energy efficiency improvements on housing costs. In doing so, it aims to bridge the gap between studies that predominantly focus on energy savings and the wider housing affordability trends identified in longitudinal surveys, providing a more nuanced understanding of how decarbonisation efforts influence affordability.

3.3 Approach and Data

3.3.1 Diff-in-Diff

Diff-in-diff methods have become commonplace among analysts interested in measuring policy impacts empirically. While their origins can be traced back to the 19th century, this subset of regression methods has been popularised in econometrics by Angrist & Pischke (2009) over the last decades. By and large, these empirical approaches rely on a combination of a treated group that receives the intervention and a control group which does not. By using the control group as a counterfactual—i.e., what would have happened to the treated group in the absence of treatment—the method aims to estimate the Average Treatment Effect on the Treated (ATT). The validity of this estimate hinges on the parallel trends assumption, which posits that, absent the treatment, the outcome variable for both groups would have followed the same trajectory over time (Blundell & Dias, 2002). If this assumption is violated, the estimated treatment effect may be biased.

A major challenge in implementing Diff-in-Diff is obtaining a valid control group that mirrors the characteristics of the treated group. To overcome this, diff-in-diff methodologies are usually implemented in conjunction with matching techniques (Imbens & Wooldridge, 2009). This approach allows on the one hand to control for time-invariant confounders through the diff-in-diff regression as well as controlling for pre-treatment differences between treatment and control group (Lechner, 2010). Matching identifies control observations that have close covariate values to those of the treated using a distance measure, usually Mahalanobis or propensity score. King et al. (2011) discuss the implications of both matching estimators in depth,

evaluating their capacity to produce balanced samples. They conclude that Mahalanobis distance may be more useful in producing balanced samples as it takes into account covariate values, while the propensity score relies on the probability that an observation receives treatment given the covariates through a logistic regression.

While no method can perfectly control for all sources of bias, Diff-in-Diff, particularly when combined with matching, offers a robust way to control for both observed and unobserved confounders. This study employs a matching methodology to build on the existing literature on housing costs, which aims to account for variations in household consumption levels. By pairing households based on pre-treatment characteristics, we can more precisely assess changes in housing costs. Specifically, we compare decarbonised households to their most similar non-decarbonised counterparts, providing a clearer evaluation of the cost differences arising from decarbonisation, while controlling for factors such as household consumption patterns. When it comes to housing costs, quasi-experiments have also been valuable in uncovering the differential impact it may have on health outcomes across homeowners and renters (Pollack et al., 2010). Diff-in-diff approaches have also been applied to the field of housing and energy transition in a number of the studies mentioned above (Ferentinos et al., 2021) (Kattenberg et al., 2023). By bringing the diff-in-diff approach to the analysis of housing costs, this paper aims to uncover unequal increases in costs across tenure groups. This method provides a straightforward empirical approach to estimate causal effects in real-world settings where randomised experiments are impractical.

3.3.2 Data and treatment

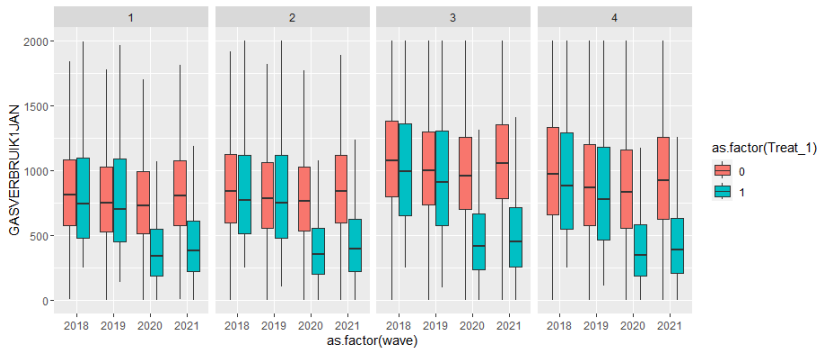
This paper draws from a large dataset of Dutch households, Woonbase, including registry and modelled data for all households in the Netherlands between 2018 and 2021 (CBS, 2024). For the purpose of this research, only households for which the housing and energy costs variables are observed have been included in the analysis. Households for which either costs of energy consumption have been modelled are excluded to ensure the relationship between energy and housing costs is adequately identified. The household and housing unit ID allow joining data for various years to create a panel dataset to which financial and energy data are merged.

Decarbonisation, as the treatment variable, is not directly observed, but it is derived from observed gas consumption, which is used as a proxy for decarbonisation. While there is no official definition of housing renovation, the EU Taxonomy offers the indication of at least a 30% reduction in primary energy consumption. This threshold, though conservative, is included in the Commission Recommendation (EU) 2019/786, which assesses medium renovations (between 30% and 60%) and deep renovations (over 60%). This paper adopts a 40% threshold as the benchmark for assessing a building as undergoing renovation, applying a more conservative approach given the use of gas consumption as a proxy. This threshold is backed by

empirical studies that find final reductions in energy consumption ranging above 20% for insulation programmes (Kattenberg et al., 2023).

Treated households are defined as those experiencing a 40% reduction in gas consumption (variable gasverbruikt in Figure 1) in the year 2020 when compared to 2019. A minimum threshold of 200m^3 of gas consumed per year is also applied, along with the requirement that the 40% reduction be sustained in the year 2021, all while household composition remained unchanged (see Figure 1). The use of observed gas consumption, rather than changes in EPCs, follows from the fact that EPCs are typically registered when a property is put on the market, even though interventions may have occurred earlier. The implications of using this proxy to assess housing renovation are discussed further in the discussion section.

FIG. 3.1 Monthly Gas Consumption 2018 to 2021 across tenures (1, Priv Renters; 2, Social Renters; 3, Mortgagors; 4, Outright Owners) and treatment, 1, and control groups, 0.



Source: Prepared by the author.

This filtering approach results in 34,408 (1% of filtered) households being identified as having undergone deep housing renovation and significantly reduced their carbon emissions (see Table for details). While this proportion is low, it aligns with national estimates of the number of households undergoing renovation, which range between 1% and 2% (Sandberg et al., 2016). Due to the high number of observations in the control group, leading to substantial computational demand, the control group was randomly sampled by tenure group to 100,000 households, except for private renters, where the number of controls was 27,579, since private renting is the least common tenure in the country.

The other main variable of interest is total housing costs (MLTOTAAL in the tables). The total housing cost variable, constructed by CBS, incorporates energy, and mortgage and/or rental costs for renters and owners. These expenses are joined by a flat maintenance rate in the case of homeowners. This adjustment justifies the use of total housing costs as the main variable of interest for both homeowners and renters, as it already incorporates a maintenance component.

FIG. 3.2 Pre-matching descriptions overall and across tenure (1: Priv Renters; 2: Social Renters; 3: Mortgagors; 4: Outright Owners) and treatment (1) and control (0) groups.

	1		2		3		4		Overall	
	0 (N=27579)	1 (N=790)	0 (N=100000)	1 (N=13381)	0 (N=100000)	1 (N=16666)	0 (N=100000)	1 (N=3571)	0 (N=327579)	1 (N=34408)
MLTOTAAL1JAN_2018										
Mean (SD)	601 (233)	557 (238)	542 (159)	505 (150)	855 (358)	865 (388)	388 (139)	411 (190)	596 (303)	671 (351)
Median	522	478	498	462	784	776	359	368	497	572
MLTOTAAL1JAN_2019										
Mean (SD)	622 (240)	578 (247)	559 (163)	524 (153)	851 (349)	844 (369)	384 (94.4)	383 (104)	600 (295)	665 (330)
Median	539	495	512	481	782	759	369	368	504	575
GASVERBRUIK1JAN_2018										
Mean (SD)	963 (421)	899 (525)	939 (389)	901 (488)	1210 (473)	1160 (592)	1210 (514)	1070 (604)	1100 (476)	1050 (567)
Median	920	770	908	793	1160	1080	1160	953	1060	937
GASVERBRUIK1JAN_2019										
Mean (SD)	894 (392)	873 (541)	873 (364)	895 (516)	1120 (443)	1080 (588)	1110 (482)	947 (574)	1020 (444)	987 (565)
Median	862	742	848	780	1080	972	1060	828	975	875
MLENETTO1JAN_2018										
Mean (SD)	NA	NA	NA	NA	641 (344)	651 (371)	188 (115)	217 (160)	253 (335)	338 (406)
Median	NA	NA	NA	NA	570	563	162	182	146	221
MLHNETTO1JAN_2018										
Mean (SD)	445 (222)	412 (226)	383 (145)	355 (134)	NA	NA	NA	NA	158 (224)	157 (210)
Median	360	332	334	300	0	0	0	0	0	0
MLENETTO1JAN_2019										
Mean (SD)	NA	NA	NA	NA	635 (335)	643 (352)	180 (65.3)	200 (76.4)	249 (327)	333 (393)
Median	NA	NA	NA	NA	566	562	166	184	150	223
MLHNETTO1JAN_2019										
Mean (SD)	456 (230)	420 (234)	390 (148)	361 (136)	0.0774 (9.22)	0.0589 (7.60)	4.22 (55.7)	3.64 (49.9)	159 (226)	150 (202)
Median	367	337	338	304	0	0	0	0	0	0
QUOTETOTAAL1JAN_2018										
Mean (SD)	35.0 (9.82)	36.9 (9.54)	31.4 (8.30)	33.3 (8.56)	22.7 (10.2)	25.0 (12.1)	15.2 (8.49)	16.2 (10.2)	24.1 (11.6)	27.6 (12.0)
Median	34.4	36.5	31.2	33.3	21.0	22.8	13.3	13.6	23.1	27.1
QUOTETOTAAL1JAN_2019										
Mean (SD)	34.7 (9.63)	36.7 (9.96)	31.0 (8.17)	33.3 (8.41)	21.7 (9.69)	23.7 (11.4)	14.8 (7.96)	15.2 (8.65)	23.5 (11.3)	26.8 (11.7)
Median	34.1	36.7	30.8	33.3	20.1	21.7	13.1	13.1	22.5	26.3
HUURKLASSE1JAN_2018										
Mean (SD)	3.36 (1.05)	3.52 (0.943)	3.62 (0.595)	3.70 (0.527)	NA	NA	NA	NA	NA	NA
Median	4.00	4.00	4.00	4.00	NA	NA	NA	NA	NA	NA
HUURKLASSE1JAN_2019										
Mean (SD)	3.33 (1.07)	3.52 (0.939)	3.62 (0.576)	3.70 (0.516)	NA	NA	NA	NA	1.39 (1.79)	1.52 (1.85)
Median	4.00	4.00	4.00	4.00	0	0	0	0	0	0
MLEHYP31DEC_2018										
Mean (SD)	0.450 (14.3)	0.141 (3.97)	0.862 (24.2)	1.16 (26.8)	613 (440)	600 (444)	0 (0)	0 (0)	187 (373)	291 (431)
Median	NA	NA	NA	NA	530	504	0	0	0	0
MLEHYP31DEC_2019										
Mean (SD)	NA	NA	NA	NA	602 (460)	576 (440)	0 (0)	0 (0)	184 (376)	279 (420)
Median	NA	NA	NA	NA	508	478	0	0	0	0
MLHKALEHUUR1JAN_2018										
Mean (SD)	598 (159)	583 (172)	528 (100)	510 (99.7)	NA	NA	NA	NA	215 (278)	221 (269)
Median	597	582	529	512	0	0	0	0	0	0
MLHKALEHUUR1JAN_2019										
Mean (SD)	610 (163)	594 (177)	536 (100)	519 (98.4)	NA	NA	NA	NA	216 (280)	216 (266)
Median	604 [113, 1880]	589 [147, 1520]	537 [110, 1460]	522 [202, 1060]	0	0	0	0	0	0
Res_Age_2019										
Mean (SD)	59.2 (18.0)	51.8 (17.0)	58.4 (16.5)	53.5 (16.3)	52.1 (13.6)	51.0 (13.7)	68.6 (10.8)	66.2 (10.8)	59.7 (15.6)	53.6 (15.3)
Median	61.0	52.0	59.0	54.0	52.0	51.0	69.0	67.0	61.0	54.0
Building_Age_2019										
Mean (SD)	1960 (73.3)	1950 (71.8)	1970 (33.1)	1970 (33.1)	1980 (37.6)	1970 (43.8)	1970 (42.9)	1970 (50.9)	1970 (42.3)	1970 (41.8)
Median	1970	1960	1970	1970	1980	1980	1980	1980	1980	1970
ELEK_2019										
Mean (SD)	1960 (1010)	1760 (1110)	2010 (1010)	1810 (1030)	3010 (1330)	2870 (1540)	2430 (1190)	2390 (1460)	2440 (1240)	2380 (1440)
Median	1750	1530	1810	1580	2840	2600	2230	2090	2210	2060
Dwelling_Type_2019										
Mean (SD)	4.51 (1.29)	4.68 (0.777)	4.32 (1.22)	4.55 (1.10)	3.51 (2.07)	3.29 (2.43)	3.31 (2.15)	3.19 (2.26)	3.78 (1.88)	3.80 (2.07)
Median	5.00	5.00	5.00	5.00	4.00	4.00	4.00	4.00	4.00	4.00
VROMHH1JAN_2019										
Mean (SD)	22600 (14800)	19800 (12500)	23200 (11900)	19900 (9860)	50300 (25400)	46200 (24400)	37000 (32800)	38300 (41400)	35600 (26700)	34600 (25700)
Median	18800	16100	20000	17500	46900	42300	30700	30900	29000	28100
P100WELVAART1JAN_2019										
Mean (SD)	25.4 (16.7)	22.1 (17.2)	22.1 (13.6)	19.7 (12.9)	63.5 (19.3)	62.7 (20.0)	74.5 (17.9)	76.0 (18.5)	51.0 (28.6)	46.4 (28.5)
Median	22.0	16.0	19.0	16.0	64.0	63.0	77.0	80.0	52.0	45.0
BESTINKH1JAN_2019										
Mean (SD)	24600 (14100)	22000 (11800)	25000 (11200)	21900 (9200)	53900 (24900)	49800 (24000)	44700 (33100)	46200 (41800)	39800 (27100)	37900 (26000)
Median	20900	18600	21700	19700	50400	46000	38400	38700	33900	32000
N_Adults_2019										
Mean (SD)	1.46 (0.791)	1.26 (0.597)	1.79 (1.11)	1.49 (0.893)	2.57 (1.22)	2.22 (1.21)	1.81 (0.782)	1.68 (0.729)	2.01 (1.10)	1.86 (1.10)
Median	1.00	1.00	1.00	1.00	2.00	2.00	2.00	2.00	2.00	2.00
Sqm_2019										
Mean (SD)	83.8 (30.9)	78.1 (29.6)	85.0 (24.7)	80.2 (23.7)	120 (41.6)	126 (57.8)	126 (54.3)	138 (81.7)	108 (45.3)	108 (55.9)
Median	80.0	73.0	84.0	78.0	115	117	118	123	103	99.0
N_Children_2019										
Mean (SD)	0.226 (0.602)	0.147 (0.471)	0.452 (0.900)	0.291 (0.712)	0.808 (1.01)	0.583 (0.936)	0.181 (0.543)	0.135 (0.463)	0.459 (0.863)	0.413 (0.824)
Median	0	0	0	0	0	0	0	0	0	0

Variables in descending order: Monthly total costs 2018 and 2019, Monthly Gas 2018 and 2019, Net Housing costs Owners 2018 and 2019, Net Housing costs Renters 2018 and 2019, Percentage of Income on housing costs 2018 and 2019, Renter Benefit Class 2018 and 2019, Base rent 2018 and 2019, Main Resident Age, Electricity Consumption, Income, Wealth Position, Disposable Income, Number of Adults, Square Meters, Number of Children. Source: Prepared by the author.

3.4 Results: Unequal Outcomes in Housing Costs

To assess socioeconomic differences between treated and non-treated households, an initial logistic regression was conducted using the treated proxy as a target (Appendix A). The results highlighted the necessity of employing a matching technique to ensure comparability between control and treatment groups. Matching helps mitigate selection bias by balancing the covariates between the two groups, thus allowing for a more accurate estimate of the treatment effect. The matching procedure was carried out using the MatchIt package (Ho et al., 2011), which provides various methods for achieving balance between groups. Based on the methodological discussion presented in the study, two potential matching methods were considered: propensity score matching (PSM) and Mahalanobis distance matching. Propensity score matching was ultimately chosen due to its effectiveness in reducing bias by accounting for the probability of treatment assignment based on observed covariates.

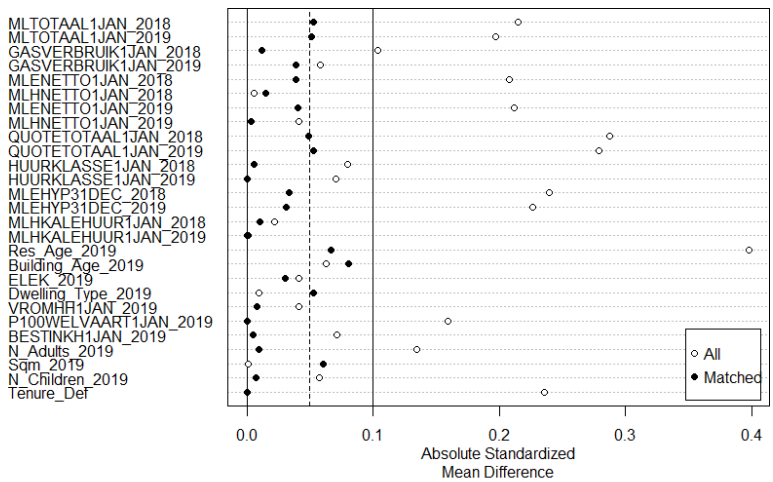
Variables such as total costs (MLTOTAAL) and wealth percentile (P100Welvaart) exhibited significant disparities before matching, underscoring the necessity of the matching process. It is important to note that by matching on variables such as income (VROMHH), the differences in the housing costs-to-income ratio between groups lose their representativeness of the broader population. After matching, the Mahalanobis distance method proved effective in reducing the absolute standardised mean differences (ASMD) for these variables. This reduction in covariate imbalance between the control and treatment groups confirms the adequacy of the chosen matching method and justifies its use in ensuring that socioeconomic differences between the groups are appropriately controlled for in subsequent analyses. Thus, the matching procedure addressed pre-existing biases and allowed for a more reliable comparison of outcomes between treated and non-treated households (See Figure 2).

The next step was implementing the diff-in-diff regression model, which includes an interaction term between treatment and period of treatment received. The set-up is the usual with fixed effects by period and household. The regression uses i for indexing individuals (or units) and t indexing time periods and incorporates covariates. The diff-in-diff model assesses the effect of treatment over time, comparing treated and non-treated households across periods, controlling for time-variant covariates, in this case, income (VROMHH1JAN) and whether or not the household receives housing benefits (HUURKLASSE).

$$Y_{it} = \beta \text{Post}_t + \gamma \text{Treat}_i + \delta(\text{Post}_t \times \text{Treat}_i) + \text{X}_{it}\theta + \mu_i + \lambda_t + \epsilon_{it} \tag{3.1}$$

- Post_t is a binary variable equal to 1 if the observation is from the post-treatment period and 0 otherwise.

FIG. 3.3 Loveplot Matching Results. Showing Absolute Standardised Mean Differences before and after Matching.



Variables in descending order: Monthly total costs 2018 and 2019, Monthly Gas 2018 and 2019, Net Housing costs Owners 2018 and 2019, Net Housing costs Renters 2018 and 2019, Percentage of Income on housing costs 2018 and 2019, Renter Benefit Class 2018 and 2019, Base rent 2018 and 2019, Main Resident Age, Electricity Consumption, Income, Wealth Position, Disposable Income, Number of Adults, Square Meters, Number of Children, Tenure. Source: Prepared by the author.

- Treat_i is a binary variable equal to 1 if the observation is from the treatment group and 0 otherwise.
- $\text{Post}_t \times \text{Treat}_i$ is an interaction term indicating the treatment effect.
- X_{it} is a vector of covariates (brutto income, net income, and housing benefit).
- θ is a vector of coefficients for the covariates.
- ϵ_{it} is the error term.

The coefficient δ on the interaction term $\text{Post}_t \times \text{Treat}_i$ captures the causal effect of the treatment in this case decarbonisation. Table 1 shows the regression results where the dependent variable is the natural logarithm of total costs (log(MLTOTAAL1JAN)). The errors are robust, clustered by household to account for serial cross-sectional correlation. Following the literature, the coefficients of interest are the interaction term between treatment and treatment period since the interpretation of the income and benefits controls is affected by pre-treatment matching. This interaction term represents the core of the diff-in-diff analysis, indicating the effect of treatment over time. The first model integrates all households, the second model accounts for private renters, the third for social renters, the fourth for owners with a mortgage, and the fifth for outright owners. The treatment coefficient is negative and significant across all 5 models, suggesting that treated households experienced and statistically significant reduction in total costs compared to non-treated households over the specified period, supporting the effectiveness of housing renovation in reducing total housing costs.

TABLE 3.1 Diff-in-Diff Regression Results

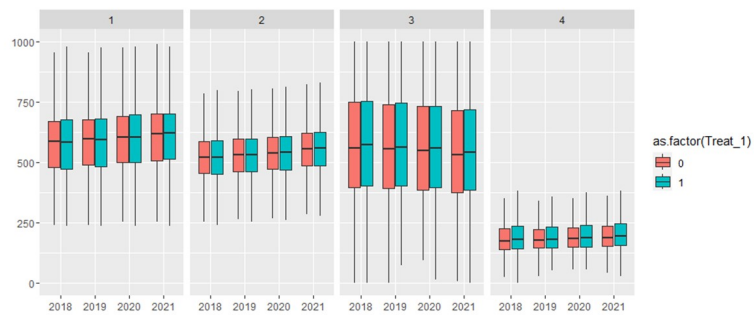
	Dep. Var: log(MLTOTAAL1JAN)				
	(0-All)	(1-Priv.R)	(2-Soc.R)	(3-Mort.)	(4-Out.Own)
Rent Ben	-4e-03***	-5.7e-02***	-5.2e-02***		
	(1e-04)	(5e-03)	(2e-03)		
Income	1e-04***	1e-04***	1e-04***	1e-04***	1e-04***
	(0e+00)	(0e+00)	(0e+00)	(0e+00)	(0e+00)
Disposable Inc	-1e-04***	-1e-04***	-1e-04***	-1e-04***	-1e-04***
	(0e+00)	(0e+00)	(0e+00)	(0e+00)	(0e+00)
T_1:P_1	-6.6e-02***	-5.8e-02***	-6.9e-02***	-5.4e-02***	-1.03e-01***
	(1e-03)	(4e-03)	(1e-03)	(2e-03)	(3e-03)
Obs.	550,528	12,640	214,096	266,656	57,136
R^2	0.389	0.582	0.576	0.372	0.327
Adj. R^2	0.185	0.442	0.434	0.163	0.102
F-Stat	6550*** (df = 4; 413k)	3290*** (df = 4; 9.47k)	5440*** (df = 4; 161k)	3940*** (df = 3; 200k)	6930*** (df = 3; 42.8k)
Note:					*p<0.1; **p<0.05; ***p<0.01

In Model 0, which includes all households, the treatment resulted in a 7% reduction in total costs for treated households compared to non-treated households over time. This serves as the baseline, representing the average treatment effect across the entire sample, irrespective of housing tenure type. The effect is both statistically significant and economically meaningful. For private renters, the treatment effect is

slightly smaller, with a 5.8% reduction in total costs. This reduction is lower than the overall household average (Model 0), suggesting that the treatment had a somewhat weaker impact on private renters. This is coherent with the academic literature which suggests private renters face more dynamic housing costs (e.g., rent fluctuations) that could moderate the effect of the treatment over time.

In the case of social renters (Model 2), the treatment effect is slightly larger than for private renters, resulting in a 7% reduction in total costs. This treatment effect is slightly stronger than the average effect across all households (Model 0) and private renters (Model 1). Social renters often face more stable or regulated housing costs, and the treatment points to energy efficiency interventions having a more pronounced impact on reducing their overall financial burden compared to private renters. For homeowners with mortgages (Model 3), the treatment resulted in a 5.4% reduction in total costs, the smallest among the different household types. Homeowners with mortgages have higher fixed costs, namely mortgage payments, which reduces the percentage impact reducing energy efficiency may have on total housing costs. As a result, the impact of the treatment in reducing a percentage of total costs is more limited for this group compared to social renters. However, this group experiences the larger reduction in absolute costs. The largest percentage treatment effect is observed for outright homeowners (Model 4), with a 10.3% reduction in total costs. This significant and larger effect suggests that outright homeowners may benefit more from the treatment as they have fewer financial obligations (e.g., no mortgage payments). This group could be more responsive to financial changes introduced by the treatment, leading to a greater reduction in their total costs.

FIG. 3.4 Brutto Costs 2018 to 2021 across tenures (1, Priv Renters; 2, Social Renters; 3, Mortgagors; 4, Outright Owners) and treatment, 1, and control groups, 0.



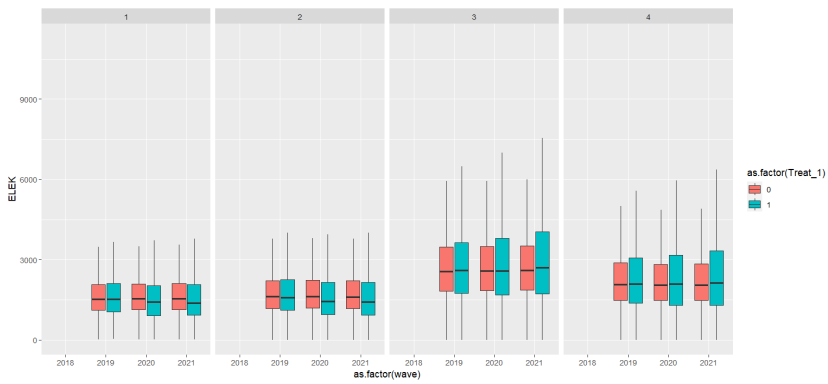
Source: Prepared by the author.

The R^2 values range from 0.327 (Model 5) to 0.582 (Model 2), indicating moderate to strong explanatory power, particularly in Model 2, where about 58.2% of the variance

in total costs is explained by the model. The lower R^2 values (e.g., 0.327 in Model 5) suggest that the model explains a smaller portion of the variance, possibly due to fewer observations. The F-statistics for all models are highly significant ($p < 0.01$), indicating that the models, as a whole, are statistically significant and that the included variables provide meaningful explanations for housing cost variation.

One of the primary limitations of these estimates arises from the lack of data on specific built fabric interventions, which introduces uncertainty into their interpretation. This unobserved data on interventions, such as insulation upgrades, installation of energy-efficient appliances, or other retrofitting measures, makes it difficult to precisely determine the causal pathways through which decarbonisation affects housing costs. However, contextualizing these estimates with data on electricity consumption patterns can provide valuable insights (Figure 3). For instance, electricity usage increases for mortgagors and outright homeowners, while it decreases for social and private renters. This divergence in consumption patterns likely reflects differences in the type of energy-efficiency interventions undertaken by these groups. For renters, the observed reduction in electricity consumption could be explained by the deployment of solar panels, which generate renewable electricity and offset a portion of grid-based consumption, ultimately reducing the need for both gas and electricity from external sources. Integrating household-level data with detailed records on the specific interventions implemented in each household would allow a more complete understanding of the impact of housing renovation. As a result, these estimates remain descriptive rather than a full exploration of the dynamics behind these estimates.

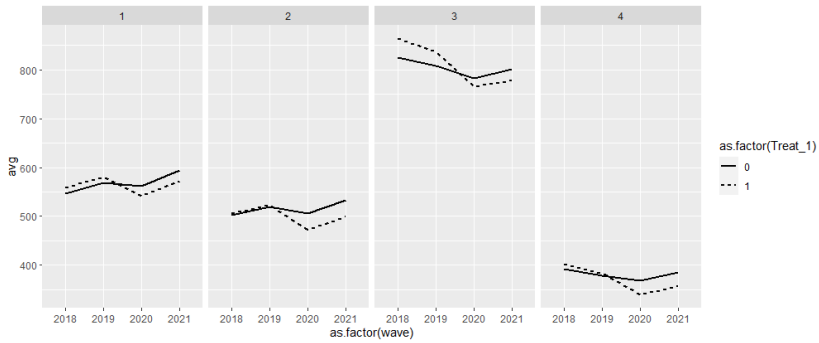
FIG. 3.5 Electricity Consumption 2018 to 2021 across tenures (1, Priv Renters; 2, Social Renters; 3, Mortgagors; 4, Outright Owners) and treatment, 1, and control groups, 0.



Source: Prepared by the author.

While the estimates control for income and energy consumption pre-treatment, and further adjustments in the diff-in-diff model account for changes in income over time,

FIG. 3.6 Model Fitted 2018 to 2021 across tenures (1, Priv Renters; 2, Social Renters; 3, Mortgagors; 4, Outright Owners) and treatment, 1, and control groups, 0.



Source: Prepared by the author.

TABLE 3.2 Summary of Estimates and Housing Costs

	Private Renters	Social Renters	Owners Mortgage	Owners Outright
Diff-in-Diff Est	5.8%	6.9%	5.4%	10.3%
Avrg Absolute Decr. Costs	-$33	-$35	-$46	-$40
Avrg Disposable Inc.	€ 1,825	€ 1,825	€ 4,150	€ 3,817
Avrg Inc./Hous. Costs aft. trt.	31%	27%	19%	9%

there remains the potential for energy poverty to affect the results. Chronic underconsumption of energy among low-income renters, particularly those in social housing, may reduce the true impact of decarbonisation interventions. Renters with limited financial resources often consume less energy out of necessity, even before interventions. This underconsumption could dampen the observed effect of energy-efficiency improvements.

Another important consideration is the endogeneity of treatment selection, particularly in the case of private renters and homeowners. Unlike social landlords, bound by minimum performance requirements (Plettenburg et al., 2021), private landlords and owners make more active decisions regarding their participation in renovation programs. This introduces potential selection bias, as those who opt into treatments may be more motivated or better positioned financially to invest in decarbonisation measures. To account for this, the results should be interpreted as the Average Treatment Effect on the Treated (ATT), rather than the Average Treatment Effect (ATE). This distinction means that the results are specific to the households that have already undergone treatment and should not be extrapolated to the broader population without caution. While matching effectively controls for variables that may influence decarbonisation outcomes, such as household income, it restricts the ability to analyse housing affordability ratios in greater detail. By matching households with similar income levels, any changes in affordability resulting from income fluctuations are effectively eliminated. Consequently, the affordability ratios presented in Table 2 are based on group averages and are used

solely as a descriptive tool, showing the average housing cost burden for each group, rather than capturing individual variations in affordability.

The findings underscore the value of longitudinal data in providing a more nuanced understanding of housing costs, particularly in relation to renovation. Point-in-time measures often miss evolving cost patterns, while longitudinal research captures the dynamic nature of housing affordability over time. Studies that model energy savings from renovation typically rely on small-scale or short-term data, which can obscure the complex and uneven effects that such improvements have on total housing costs.This gap between a narrow focus on energy savings in renovation studies and the broader trends in housing affordability identified in longitudinal research signals an important area for further investigation.

However, there are substantial limitations in our approach. Notably, our sample focuses on households that have not relocated; larger rent increases may be more likely when renovations are carried out before new tenants move in. The type of renovation also plays a role, as evidenced by the diverging impacts on electricity consumption. After renovations, homeowners tend to see an increase in electricity use, while renters experience a decrease, suggesting that different types of improvements are more common among different tenure groups. These variations highlight the importance of understanding how different interventions affect housing costs across the spectrum of tenures.

3.5 Capitalisation and Housing Costs

This section builds upon the results of the did regression, extending the findings drawing from economic of housing markets to assess welfare impacts across various housing tenures. Housing markets play a critical role in determining individual welfare, especially in urban settings, as households derive utility from both the consumption of housing services and the potential investment in homeownership. Changes in housing costs—such as those brought about by energy efficiency improvements—can have significant implications for welfare across different tenure types, reflecting both immediate consumption benefits and longer-term investment effects. According to Poterba (1984), reductions in housing costs capitalize into property values, thereby increasing the wealth of current homeowners. Goodman (1988) illustrates that such capitalised benefits enhance homeowner utility, particularly in markets with inelastic housing supply. More recently, Hilber and Vermeulen (2016) emphasise that young renters, who typically aspire to homeownership, may face reduced welfare as rising property values make ownership less accessible, especially in constrained housing markets. Drawing from these two precepts, the capitalisation of costs reductions and the disutility of increased house

prices for renters, it is possible to explore welfare changes between renters and homeowners resulting from the housing costs reductions.

The welfare change equations for renters and homeowners assess the effects of housing cost reductions on each group by combining consumer surplus and property value changes(Appendix B provides the full analysis). For homeowners, the welfare change equation ($\Delta W_{\text{homeowners}}$) also includes the consumer surplus increase from reduced costs, captured by the first term. However, unlike renters, homeowners benefit from the capitalisation of cost savings into property values. This additional wealth effect is captured by the second term, where κ represents the proportion of savings that capitalises into property value, and PV_{savings} is the present value of these cost savings over time, discounted to reflect the time value of money. This second term thus captures the increase in property wealth for homeowners, reflecting the dual benefits they receive from both reduced housing costs and enhanced property value.

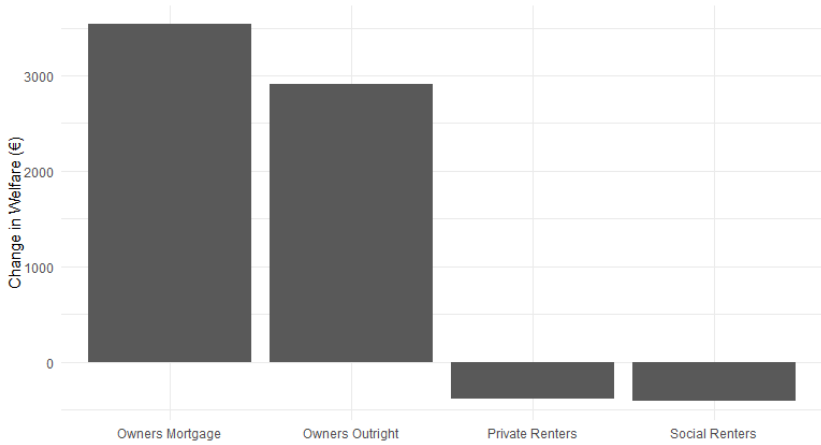
$$\Delta W_{\text{homeowners}} = U_1 - U_0 = CS_1 - CS_0 + \kappa \cdot PV_S.$$

For renters, the welfare change equation ($\Delta W_{\text{renters}}$) includes the consumer surplus gained from cost reductions, represented by the first term, which measures the difference in surplus from the initial cost C_0 to the reduced cost C_1. Here, $D(C)$ represents the demand for housing as a function of these total costs. As costs fall, property values (P) tend to rise, and the second term incorporates renters' disutility from this increase, scaled by the parameter α, which reflects the extent to which rising property values reduce renters' welfare by making homeownership less affordable.

$$\Delta W_{\text{renters}} = U_1 - U_0 = CS_1 - CS_0 - \alpha \cdot (P_1 - P_0),$$

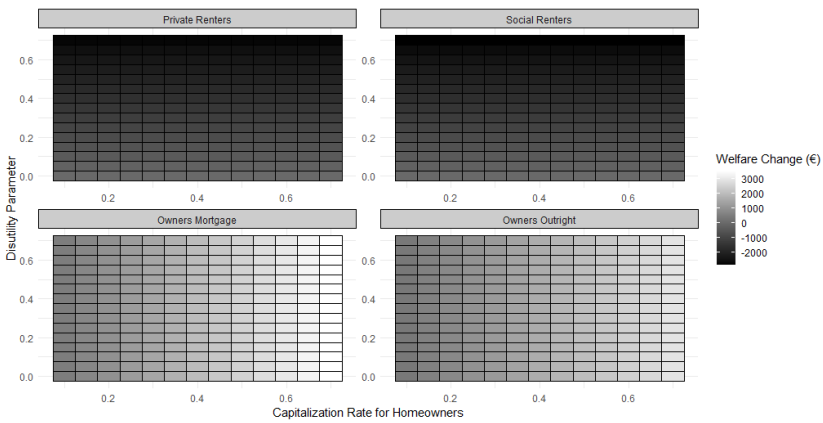
Figure 8 shows the numerical results if we calibrate these two equations to assume that 70% of cost savings are capitalised into property values, κ, over a 20-year horizon, discounted at a rate of 10%. For renters, the disutility α, is calibrated to 10 %. Even calibrated in this conservative manner, these results show a reduction in welfare for social and private renters while homeowners both mortgagors and outright owners experience larger increases in welfare. Figure 9 develops a sensitivity analysis of these parameters to show that renter utility becomes negative with very low capitalisation and disutility from house price increases. These differences are especially relevant for low-income households, which already face disproportionately high housing costs (Burlinson et al., 2018). For these households, energy savings alone may not provide sufficient relief from broader affordability challenges, as energy costs represent only a fraction of their total housing expenses. These results show that addressing overall housing affordability requires a more comprehensive approach to unpack how renovations impact different tenure groups and income levels.

FIG. 3.7 Welfare Analysis



Source: Prepared by the author.

FIG. 3.8 Sensitivity Analysis Capitalisation and Disutility Parameters



Source: Prepared by the author.

These results are especially relevant in the context of energy and housing renovation policies in the Netherlands. The country's energy taxation system raises energy costs, disproportionately affecting lower-income households. Maier and Ricci (2022) highlight that this taxation system is regressive by European standards, placing a heavier burden on lower-incomes. At the same time, generous subsidy programs in the Netherlands provide substantial financial support for homeowners to renovate, lowering their overall housing costs. As Fernández et al. (2024) note, homeowners benefit not only from reduced energy consumption but also from the increased value of their property, making renovation an even more financially advantageous option. Conversely, renters face rising housing costs without the potential financial gains of property ownership, making them more vulnerable to the indirect effects of policies such as carbon pricing and the Energy Taxation Scheme (ETS), one of the flagship policies of the European Union, Directive (EU) 2023/959, that will come into force in 2027-2028. While the Social Climate Fund will redirect a proportion of the revenue from this tax towards lower-income households and the social renting sector, doubts remain regarding the capacity of this stream of revenue in reverting plausible regressive outcomes (Defard & Thalberg, 2022). Engraining discussion of the differential impact of housing decarbonisation on costs reinforces the need to account for costs while designing environmental policy.

3.6 Conclusion

This study applies a diff-in-diff approach to housing costs providing exploratory insight into the socioeconomic implications of decarbonisation and housing renovations in the Netherlands. The combination of a diff-in-diff with a matching technique, drawing from Mahalanobis distance, mitigates selection bias and enhances the validity of the treatment effect estimates. The findings indicate a significant reduction in total housing costs for treated households across various tenure types, with outright homeowners benefiting the most in percentage terms, mortgagors benefitting the most in absolute terms although benefitting the least in terms relative to their total housing costs, followed by social and private renters. The heterogeneity in treatment size across tenure types underscores the complex interplay between housing costs and energy-efficiency policies, emphasizing the importance of integrating total housing costs into the analysis of energy transitions. These findings are, however, constrained by a lack of data on specific physical interventions (e.g., insulation, solar panels or heat pumps).

While energy-efficiency interventions have clear benefits through the reduction of energy consumption, their impact on overall housing costs is nuanced and varies across socioeconomic groups. As shown in the welfare analysis which account for the capitalisation of cost savings on property values. Renters, may not fully experience

the benefits of renovation due to rent hikes or lower baseline in energy consumption and may see their disutility increase because of the capitlisation on property values of costs savings in the ownership sector. Conversely, homeowners benefit both from energy costs reduction and property value appreciation.

In conclusion, this study suggests that current renovation subsidies and energy taxation structures, while aimed at promoting decarbonisation, may widen not only differences in resident welfare, but also in housing costs between homeowners and renters. As such, the study points to the need for more targeted policies, such as the Social Climate Fund, to ensure a more equitable distribution of the costs resulting from decarbonisation and energy efficiency. Ultimately, the paper contributes to the ongoing dialogue about the intersection of housing policy, energy transition, and social equity.

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4 Subsidies or Green Taxes?

evaluating the distributional effects of housing renovation policies among Dutch Households

Abstract[1]

Despite persistent housing affordability issues, energy policy and housing renovation are usually investigated separately from housing costs other than energy. Researchers have examined the financial viability of renovation attending to building conditions and the socio-economic characteristics of their occupants. However, the distributional impacts of renovation incentives and the potential of fiscal policy to redistribute housing costs remain understudied. Dutch fiscal policy, favouring homeownership, offers a relevant context to evaluate how property taxation can boost renovation rates. The novelty of this paper resides in investigating the impact of two policies, the current direct subsidy and a proposal for a green tax, on both the financial viability of renovation and the subsequent distribution of housing costs. The proposed green tax combines energy efficiency and taxation of property revenue. We employ a model considering marginal costs of housing renovation, obtained from a government dataset, and marginal benefits, drawn from a hedonic regression. We assess the distributional impacts of different policy scenarios by examining changes in user costs across income deciles. Our findings indicate that existing renovation subsidies exacerbate the regressive distributional impacts resulting from the current housing taxation system in the Netherlands. Introducing energy-efficiency-linked property taxation can make homeownership fiscality less regressive while incentivising housing renovation. Ultimately, this study highlights the importance of incorporating housing affordability as a fundamental element in renovation policies to balance environmental and distributional objectives.

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4.1 Introduction

Since its inception in 2002, the Energy Performance of Buildings Directive (EPBD)(2002/91/EC) has been the cornerstone of building standards across EU Member States (MSs). The EPBD has progressively broadened its scope through successive recasts, 2010/31 and 2018/844. At first, this directive established only optional reporting and certification guidelines in the form of Energy Performance Certificates (EPCs). In subsequent recasts, the EU has strengthened its demands requiring MSs to define specific plans to phase out the worst energy-performing building stock (Bertoldi et al. 2021) (Economidou et al. 2020). At the time of writing, in the midst of an energy crisis, debates at the European Parliament on a new EPBD recast underline the relevance of energy efficiency in achieving carbon neutrality by 2050 (Ernould, 2022).

Concurrently, the European Commission (EC) has also launched the Renovation Wave (COM 2020 662), an action plan assessing the budgeting solutions that the EU could draw on to support housing renovation. The Renovation Wave estimated that 275€ billion of public and private investment a year are needed to attain the 55 % reduction in emissions by 2030 envisioned in the EU's Climate Target Plan. The Renovation Wave builds on a series of initiatives by MSs which have fostered the viability of renovation through an array of subsidies including grants and low-interest loans with a clear focus on owner-occupied housing (Castellazzi et al., 2019).

The financial viability of housing renovation hinges on its costs and the resulting value increase of an energy-efficient home (Copiello & Donati, 2021). The value increase of energy-efficient improvements in real estate markets usually takes the form of a green premium identified through different econometric techniques, see for example Aydin et al., (2020) for a recent study of property premiums in the Netherlands. To increase the financial viability of renovation, the EU proposes two approaches that have been incorporated differently by MSs (Bertoldi et. al, 2021). On the one hand, grants and loans rely on the reduction or complete elimination of up-front costs –a carrot approach– to encourage renovation (see for example, Eryzhenskiy et al. 2022). On the other hand –the stick side of housing renovation incentives– draws, first, on mandatory Minimum Performance Standards (MEPSs) which preclude the renting or selling of properties under a certain EPC level (Economidou, et al, 2020). Second, the EC also plans to expand the Emissions Trading Systems (ETS) to encompass buildings before the end of the decade (2003/87/EC). This will likely impact energy costs and increase the viability of energy-efficient renovations (Backe et al., 2023).

In the Netherlands, when it comes to owner-occupied housing, MEPSs have not yet been defined. Instead, the government has put in place a series of subsidies and loans to incentivise renovation. Homeowners can access different forms of grants covering up to half of the renovation costs when they insulate or change the heating source in their homes (Ministry of Economic Affairs and Climate Policy, 2019). Since

2022, 0% interest loans are also available to low-income households from the National Heat Fund. On the stick side, the Netherlands implements a form of carbon taxation on individual households which has produced, according to the Joint Research Centre (JRC), regressive effects, that is taxing those on lower incomes comparatively more (Maier & Ricci, 2022). Despite the direct link between renovation subsidies and housing costs (Haffner, 2003) together with the regressiveness in current carbon taxation (Maier & Ricci, 2022), the distributional impact of renovation on affordability remains understudied. While this gap in knowledge is substantive to the Netherlands, it also speaks more broadly to the incorporation of renovation within the study of housing affordability.

Housing affordability is arguably one of the most pressing issues in the Netherlands. Despite a nuanced descent in 2023, house prices have been on the rise for more than a decade with 19.5% increases year on year in Q1 2022 (CBS, 2022). However, housing costs are not equally distributed across the population and present stark differences by tenure. Dutch homeowners, even those on low incomes, are among the least likely to be overburdened with housing costs, that is spend more than 40% of their income on housing (OECD, 2022). Conversely, the median burden of rent payments for tenants, 30%, is the second highest among OECD countries (OECD, 2022). Notwithstanding the Dutch housing market heading toward price correction in 2023, chronic inequalities in access to housing have created a cleavage between "insiders", homeowners, and "outsiders", renters (Arundel & Lennartz, 2019). Despite housing costs being a major driver of inequalities between tenures in the Dutch context, these considerations are absent in the design of housing renovation policies and the academic discussion on housing renovation. This has so far focused on post-renovation energy savings and subsidy uptake across households due to low-income levels or built fabric determinants, see for instance Brom et al., (2019) and Sunikka-Blank & Galvin (2012), and also McCoy & Kostch (2021) for the distributional impacts of built components in housing renovation in the UK.

Furthermore, in the Netherlands, renovation subsidies come to join a series of distortive tax deductions favouring homeowners (Fatica & Prammer, 2018). As a result, it is critical to understand the impact housing renovation subsidies have on affordability to account for their distributional impact on housing costs. The recent comparative study of housing taxation by Millar-Powell (2022) has explored how housing taxation is underutilised and shows that adapting effective tax rates across income lines can help reduce inequalities in the housing market. In the Netherlands, the withdrawal of mortgage deductions would produce the largest increase in the Marginal Effective Tax Rate of debt-owned housing among all OECD countries, 67.7 points (Millar-Powell, 2022). Proposals have been made to substitute these forms of inefficient housing taxation with a Land Value Tax (LVT) (Allers, 2020). The Netherlands shares a lot of these traits with the UK where an LVT has also been proposed as a substitute for council tax, a regressive form of housing taxation (Mirrlees & Adam, 2011). Particularly apposite in this context is a proposal made by Muellbauer (2018) linking housing taxation to energy efficiency through a Green Land Value Tax (GLVT) designed to be progressive while incentivising housing renovation. Moreover, in 2022, an EC discussion paper also highlighted the potential of immovable property taxes to support the green transition and reduce inequalities

(Leodotler et al. 2022).

Building on the discussion about taxation and housing renovation, this paper proposes to take a broader view of energy efficiency measures as a fundamental component of housing affordability. We propose expanding the scope of analysis to incorporate renovation policies in the distributional assessment of housing costs. In this vein, we pose the question: How do the financial incentives and distributional impacts of housing renovation policies vary across different tax scenarios? Our approach relies on a hedonic regression to identify green premiums combined with a distributional analysis of housing costs under two simulated scenarios: 1) the current subsidy and 2) a green tax model. By addressing the financial viability of renovation and its distributional impacts, this paper aims to elucidate the capacity of large-scale housing renovation to produce winners and losers affecting housing affordability unequally across income groups.

The next section introduces the relevant literature on econometric approaches to hedonic pricing valuation together with the analysis of housing costs. Then, the policy background section presents different concepts regarding housing taxation benchmarks as well as the most common financial incentives for housing renovation. The third section focuses on the data and the methodology composed of the econometric approach and the user costs of housing. The fourth and fifth sections respectively showcase the results and discuss their policy implications. Finally, the last section concludes and offers directions for further research.

4.2 Literature and Background

4.2.1 Hedonic Pricing and Green Premiums

Housing prices at the micro level have traditionally been investigated using hedonic valuation models, following Rosen (1974). In these models, housing is viewed as a heterogeneous good—a vector of characteristics— that can be individually priced through the regression of the different elements on price. This approach estimates P(z) from market data first and secondly, uses first-order conditions and marginal prices to deduce preferences. While Rosen's model traces prices it does not differentiate between producers' offer and households' demand for housing services. To address this identification problem, shortly after Rosen's work, Witte et al.,(1979) developed a model with simultaneous equations where they assumed that neighbourhood quality and accessibility are shifters of bid and offer curves.

In the last decade, Rosen's hedonic pricing model has been widely applied to EPCs. EPCs are the main measure of energy efficiency in Europe ranking properties from most energy efficient, A, to least, E. In the United Kingdom, Fuerst et al., (2015) used repeated sales data to identify the influence of EPCs on price appreciation. This paper found a positive effect of energy efficiency on house prices, about 5% for dwellings rated A/B compared to those rated D. The differences between stock types were particularly striking, with premiums of 4.5% for townhouses versus only 1.6% for apartments. In this case, the authors note that the markups are consistent with retrofit costs. In the Netherlands, Brounen & Kok, (2011) used a Heckman two-step method in a hedonic pricing regression with an Instrumental Variable (IV) for identification. They identified a 3.7% premium for dwellings with A, B or C ratings. This premium goes up to 10.2% for A-rated units. This paper finds that energy premiums are higher than the capitalisation of energy savings pointing to unobserved characteristics related to the materials used in construction. The need for identification and the use of instrumental variables has been disputed by Cheshire & Sheppard (1998) who find that identification is of minor significance for the estimation of elasticities. Similar work has been conducted using only cross-sectional housing survey data. Ayala et al. (2016) established a premium between 5.4% and 9.8% for energy-efficient dwellings in Spain. Cerin et al., (2014) offer similar results for Sweden using an OLS regression; however, these were contingent on the property-price class with higher-value dwellings acquiring higher premiums and least expensive ones showing negative price-energy efficiency correlations. Also, in Sweden, Wilhelmsson, (2019) used a propensity score to compare treated houses with a control group and found a 3.36% premium, with higher impacts depending on regional climate.

More recently, also in the Dutch context, Aydin et al. (2020) used an (IV) approach to assess the capitalisation of energy efficiency in house prices. They found that a 10% increase in energy efficiency leads to a 2.2% increase in market value. Their approach is quasi-experimental and relies on a time discontinuity in the quality of housing construction in the Netherlands resulting from the introduction of the first construction code in 1965 and the oil crisis in 1974, which lead to significantly more energy-efficient dwellings. In the case of the rental market, retrofit expenses create split incentives where the landlord makes the investment but the energy savings are reaped by the tenant. Research by Fuerst et al., (2015) has shown however that these dwellings also command a small, 6%, but significant premium in the rental market. In an expansion of the traditional hedonic pricing model, this paper also uses time-on-market as the dependent variable also points to a weak negative relationship between time on the market and energy efficiency ratings. Groh et al., (2022) also find a substantial premium for energy-efficient dwellings in the German rental market, however, according to them, this premium is not enough to increase the financial viability of renovation in all cases. This research stream's main conclusion is that property premiums are complex and driven by local specificities; however, there is a price retribution to renovation that varies in size depending on household characteristics and subjacent property value.

4.2.2 Housing Affordability and Taxation

Ultimately, green premiums are a form of asset value uplift connected to housing costs through a household's balance sheet (Haffner, 2003). Traditionally the viability of renovation is assessed through a Discounted Cash-Flow (DCF) analysis of saved energy, which is highly contingent on the discount rate (Copiello & Donati, 2021). Copiello and Donati (2021) propose instead to use the capitalisation of energy savings into housing value which circumvents discounted predicted energy savings as these are already priced in the property value. Following this line of work, these two authors employ an asset approach to analyse renovation viability by assessing costs and benefits in the form of value increases. Poterba (1984) first developed the asset approach to housing which understands the dwelling as an investment producing a series of services, an income, which ought to be subject to taxation. This type of asset approach to housing affordability has been usually undertaken through the concept of capital user costs. These have been used to assess both the costs of owner-occupation (Haffner & Heylen, 2011) and the distributional impacts of housing taxation (Fatica & Prammer, 2018). The concept of user costs also provides a segue into housing taxation as these are employed in the definition of housing subsidies (Poterba, 1984) (Haffner, 2003).

Government action through subsidisation or taxation affects housing costs, historically favouring homeownership over renting (Howard, 1997) (Kemeny, 1981). Following this research stream, housing subsidisation does not only take the form of direct housing allowances but can also be engrained in fiscal policy through the under-taxation of homeownership vis-à-vis other investments (Haffner & Oxley, 1999). This under-taxation can be considered a subsidy, defined as a reduction in the price of housing services, which can ultimately make a consumer biased towards a particular tenure. Haffner (2003) proposes to draw from user costs to analyse subsidisation. Arguably, user costs are a more comprehensive measure of housing costs than cash flows since the former includes changes in value through accrual accounting measures while the latter is limited to pecuniary exchanges. Equations 1 and 2 show these differences between user costs and cashflows for homeowners with a mortgage, where r stands for interest, D for debt, PP for principal payment, OC for Operating Costs, V for value, δ for depreciation, and ρ for premium, expected value change.

$$Cashflow_{(t+1)} = r \cdot D_t + PP_{(t+1)} + OC \tag{4.1}$$

$$UserCosts_{(t+1)} = r \cdot V_t + \delta \cdot V_t - \rho \cdot V_t + OC \tag{4.2}$$

The equalisation of user costs across tenures can take different forms such as capital gains or imputed rent taxation in income tax, as Table 1 shows (Haffner, 2003). The objective of these taxes is to treat the proceeds of homeownership as those from other types of investment – tax neutrality (Mirrlees & Adam 2011). According to the Mirrlees review (2011), tax neutrality is the elimination of arbitrariness in fiscal burden across households and activities. When it comes to the taxation of housing as

an asset, the Mirrlees Review proposes to allocate a Rate-of-Return Allowance (Mirrlees & Adam, 2011), a form of capital gains taxation. Mirrlees' fiscal proposal would allow the (partial) deductibility of mortgage interest. In turn, it would tax excess returns over the rate of allowance leaving households indifferent between investing in owner-occupied housing or renting and investing in other assets. Imputed rent taxation, that is the taxation of the services provided by a housing asset, is another form of achieving tax neutrality across tenures. However, the implementation of tax neutrality is particularly challenging since this benchmark is usually far from the actual fiscal policy which often favours homeownership (Mirrlees & Adam, 2011) (Haffner & Oxley, 1999). Comparative research across Europe has shown that mortgage interest deduction together with the lack or under-taxation of services from owner-occupied housing are the main fiscal instruments producing inequalities in costs across tenures (Fatica & Prammer, 2018). More broadly, Kholodilin et al. (2022) have linked the expansion of ownership subsidisation, through mortgage deductions and undertaxation, to the abolition of rent controls and negative consequences for affordability.

Microsimulation techniques are one of the main tools used in the study of fiscal policy and its distributional consequences. Microsimulations allow to design counterfactuals against which reforms can be assessed (Bourguignon & Spadaro, 2006). This is particularly relevant when assessing tax and benefits as they shed light over the winners and losers under different scenarios. For example, in the UK, Clark & Leicester (2005) show how income tax cuts increased inequalities while increases in means-tested benefits reduced them. When it comes to housing, Figari et al.(2019) use EUROMOD, the multi-country tax benefit calculator of the EU, to analyse the distributional consequences of including net imputed rent in the taxable income while removing the special tax treatment of homeownership. Through this counterfactual exercise, they identify a homeownership bias which could be remedied by raising taxes without regressive effects.

Following these fiscal imbalances between owner-occupied housing and other assets, the OECD has called for the reform of these fiscal policies and the introduction of more progressive forms of taxation of housing assets over the lifecycle, for example with the taxation of housing income through imputed rent during occupation and capital gains at disposal (Millar-Powell, 2022). Country-specific studies have

TABLE 4.1 Taxes and Subsidies for Housing and Energy

	Asset/Investment Approach	Housing services/ Consumption Approach
Housing	Imputed Rent Taxation Mortgage Interest Deduction Capital Gains Taxation	Housing Allowance Renovation Subsidies
Energy	Green Housing Taxation	Energy Allowance Carbon Tax Emissions Trading Scheme

explored how changes in policymaking can tilt housing taxation towards the optimal levels defined in the Mirrlees Review (2011). Haffner & Winters (2016) have analysed fiscal changes in the Belgian Region of Flanders and benchmarked five European countries against tax neutrality. They find that tax neutrality is challenging to implement but the Flemish changes in fiscal policy, reducing the mortgage deduction, did move housing taxation towards the optimum. Heylen (2013) has shown how the Flemish housing tax advantages for owner occupation are received by tax payers with the highest incomes and the average owner-occupier receives fourfold the subsidy amount of the average tenant. When it comes to house improvements, Heylen (2013), also shows how the reduced VAT in the case of home improvement is positively related to income, a particularly relevant finding in the context of the energy-efficient renovations.

4.2.3 Housing Renovation Subsidies in The Netherlands

Subsidisation, through grants and loans, as well as tax rebates are commonly used across Europe to incentivise the energy-efficient renovation of the housing stock (Castellazzi et al., 2019). Following this trend, the Dutch government has put in place a series of grants and subsidised loans to incentivise renovation. First, the "Subsidie Energiebesparing Eigen Huis" is a grant programme covering up to 50% of renovation costs when at least two energy-saving measures improving EPC levels have been implemented. Dutch homeowners can also apply for the Investment Grant for Sustainable Energy Savings (ISDE) in the case of single measures such as solar boilers or heat pumps (Ministry of Economic Affairs and Climate Policy, 2019). Since 2022, 0% interest loans are also available to low-income households from the National Heat Fund. On the stick side, as mentioned above, the Netherlands implements a regressive form of carbon taxation on individual households (Maier &Ricci, 2022). On a similar note, research by the Dutch National Bank has also alluded to the strong impact of energy taxation on lower incomes and the inelasticity of energy consumption. Havlinova et al.,(2022) have found that the introduction of stronger forms of energy taxation in heated energy markets can impinge on lower incomes resulting in regressive distributional impacts. See Table 1 for a classification of housing taxes and subsidies. At the EU level, the Renovation Wave is actively promoting this approach to housing renovation through its proposal to include buildings in the Emissions Trading Scheme (ETS) together with the implementation of renovation subsidies(2003/87/EC). As a result, while owner-occupied housing is undertaxed, the tax burden on energy consumption at the household level is poised to increase.

As the research presented above has shown, renovation subsidies usually come to join fiscal systems favouring owner occupation. These forms of direct subsidisation of housing renovation coalesce with increases in the fiscal burden on energy consumption. According to Haffner & Heylen (2011), the housing taxation structure favours owner-occupation with a mortgage through large deductions in income tax.

TABLE 4.2 Taxation Benchmarks - Year 2021

Current tax - Imputed Rent	Box 3 - Tax Neutral Benchmark	Imputed Rent with Green Element
(Dwelling Value*Notional Rental - Mortgage Deduction)* Income Tax Rate	Tax base* Return* Tax Rate (31%)	(Dwelling Value*Notional Rental*Pondering by EPC-Mortgage deduction)*Income Tax Rate
Up to €12.500 of house value: 0%	1) Taxable Return: Savings* 0.01% + Other wealth * 5.69% - Debt * 2.46%	A/B = 0.8
€12.500 – €25.000: 0.15%	2) Equity: Wealth - Debt	C = 1.4
€25.000 – €50.000: 0.25%	3) Return Percentage: Taxable return amount / Total owned wealth	D = 1.6
€50.000 – €75.000: 0.35%	4) Tax Base: Owned wealth - Debt - Exemption	E = 1.8
€75.000 – €1.130.000: 0.45%		F = 2
More than 1.130.000: €5.085 + 2.35% of value above €1.130.000		G = 2.2

In the Netherlands, imputed rent, the main form of housing taxation is calculated on the basis of a notional rent value and then added onto Box 1 which comprises labour income. All other income from investments is taxed under box 3 at a different rate. Haffner and Heylen (2011) have analysed the lack of tax neutrality in this system and propose to include the taxation of housing assets under box 3 as a tax-neutral benchmark. In the context of housing renovation, the favourable fiscal treatment of homeownership comes to join generous subsidies for owner-occupied housing renovation with no maximum income threshold offered by the Dutch government.

As a response to the regressiveness of housing taxation and the subsidisation model of housing renovation, Muellbauer (2018) has proposed a form of GLVT. This tax would take into account land occupation and energy efficiency to excise more on those occupying more land with less energy-efficient buildings. Although there is no land value taxation in the Netherlands, the Dutch case remains particularly apposite to test green taxation proposals through imputed rent. The work of Davis et. al (2017) is also particularly relevant in this context as it combines EPC modelling with property values and taxation arguing for the redistributive potential of this approach. Drawing from the literature presented above, the Netherlands lacks tax neutrality across tenures and imposes regressive taxes on energy consumption. These renovation incentivising policies result from a consumption interpretation of housing renovation as a one-off expense, not as an investment resulting in the appreciation of a financial asset (Copiello & Donati, 2021). Albeit under-taxing it according to the literature presented before, Dutch fiscal policy treats owner-occupied housing as an asset (Haffner, 2003). Aligning incentives for renovation with the asset interpretation of housing present in fiscal policy opens up paths for a set of green tax tools. This paper builds on Haffner and Heylen's (2011) interpretation of tax neutrality to analyse the distributional impacts of housing renovation. The proposed green taxation framework follows Muellbauer (2018); however, it does not rely on land value but is embedded in the current Dutch imputed rent taxation system (see Table 2 for detail).

4.3 Methodology and Data

The objective of this analysis is twofold. On the one hand, we discuss the redistributive potential of green-imputed rent taxation. On the other hand, we also assess the impact of green taxation on the financial viability of renovation in comparison to the current subsidy model. These issues come together in three research sub-questions: 1) What are the distributional impacts of current and green imputed rent taxation compared to a tax-neutral benchmark? 2) How do the current subsidy and green taxation affect the financial viability of housing renovation? 3)What are the distributional impacts of subsidy and green taxation scenarios on

housing costs? By bringing together the literature on housing affordability and housing renovation, we want to assess the potential role fiscal policy can play in the alignment of social and environmental goals.

This paper draws from the model of marginal benefits and costs used by Copiello and Donati, (2021) which itself builds on Marshall's marginal utility theory and was previously used in the analysis of energy efficiency by Jakob (2006). Recently, Groh et al. (2022) have also employed this model to analyse renovation viability in the German rental market. Marginal Benefit (MB) is the benefit increase resulting from one additional unit of activity, conversely, Marginal Cost (MC) is the rise in cost derived from one unit of activity. These are calculated as per equations 3 & 4 where TB is the total benefit, that is the increase in value resulting from energy efficiency improvements, TC is total costs, the costs of energy efficiency improvements and ΔEPI is the change in the Energy Performance Index (EPI) a measure of kWh/m2/year which in our case is derived from an EPC average.

$$MB = \Delta TB / \Delta EPI \tag{4.3}$$

$$MC = \Delta TC / \Delta EPI \tag{4.4}$$

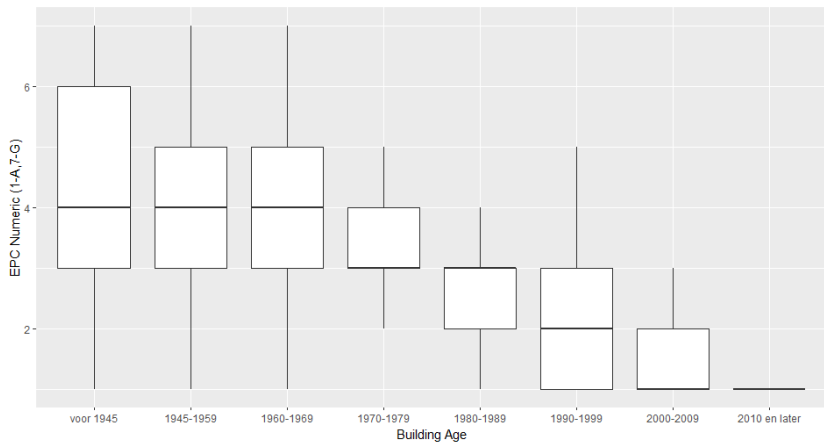
As opposed to the use of NPV calculations highly dependent on discount rates (Copiello 2021), the use of marginal costs and benefits allows to analyse the financial viability of renovation drawing from parameters already present in the data. As introduced above, hedonic pricing regressions have been the traditional tool for the estimation of property premiums, that is the marginal benefit side of the model. Drawing from the economic literature presented in the review section, this paper implements an IV approach to identify property premiums. An instrumental variable serves to determine accurate estimates through the elimination of endogeneity biases (Angrist & Pischke, 2009). In this case, endogeneity in the EPC coefficient is likely the result of reverse causality and simultaneity bias between EPC and the target variable, price per square meter. Aydin et al. (2020) argue that unobserved determinants of home prices influence the EPI coefficient. Also, multicollinearity between the year of construction and EPI may increase the bias when controlling for the construction year. Finally, Aydin et al. (2020) contend that measurement error is another source of bias, which in this case could be reinforced through the use of EPC certificates and EPI averages.

$$log(€/sqm) = \beta_0 + \beta_1 EPC + \beta_2 Cohesion + \beta_3 Urbanisation + \beta_4 Municipality + beta_5 BuildingType + \beta_6 Region + \beta_7 BuildingAge + \epsilon \tag{4.5}$$

$$EPC = \alpha_0 + \alpha_1 €/sqm) + \alpha_2 Cohesion + \alpha_3 Urbanisation + \alpha_4 Municipality + alpha_5 BuildingType + \alpha_6 Region + \alpha_6 BuildingAge + \nu \tag{4.6}$$

According to Angrist & Pischke (2009), the use of IV in two-stage least squares equations (2SLS) relies on finding a variable that is correlated with the endogenous regressor of interest and is independent of the measurement error. This paper draws from Aydin's et al. (2020) approach in the use of age of construction as an IV to ascertain renovation premiums. While Aydin et al. exploit the discontinuity between dwellings built before and after 1974, as presented in the economic literature section, we use age of construction in a continuous form through year of construction groupings. EPCs are strongly correlated with age of construction as older stock tends to be less energy efficient, fulfilling the relevance condition (see Figure 1). We assume age of construction to be random and not directly related to price except through energy performance. This approach allows identifying the impact of a higher EPC on house value. The identification premise is that holding prices, resident incomes, neighbourhoods, and regions constant, the age of a building allows capturing the causal impact of higher energy efficiency on house value. In this vein, the first and second stage regressions can be formulated as equations 7 and 8.

FIG. 4.1 Boxplot: Building Age and Numeric EPC (1-A, 7-G)



Source: Prepared by the author.

$$EPC = \alpha_0 + \alpha_1 log(€/sqm) + \alpha_2 Cohesion + \alpha_3 Urbanisation + \alpha_4 Municipality + \alpha_5 BuildingType + \alpha_6 Region + \alpha_6 BuildingAge + v \quad (4.7)$$

$$log(€/sqm) = \beta_0 + \hat{\beta}_1 EPC + \beta_2 Cohesion + \beta_3 Urbanisation + \beta_4 Municipality + \beta_5 BuildingType + \beta_6 Region + \epsilon \quad (4.8)$$

TABLE 4.3 Descriptive statistics - WoON 2021

Statistic	N	Mean	St. Dev.	Min	Max
Euro per sqm	22,913	2,629.9	1,168.5	50.4	32,200.0
Cohesion	22,913	6.5	1.8	0.0	10.0
Building Age	22,913	4.4	2.2	1	8
Urbanisation	22,913	2.4	1.2	1	5
EPC (1-A; 7-G)	22,913	2.8	1.6	1	7

The WoON dataset is used for the estimation of property premiums (BZK et al., 2022). WoON is a large household-level dataset obtained through the periodical survey of Dutch households complemented with registry data. Its 2021 iteration included 40.000 respondents. About half of the responses included Energy Performance Certificates (EPC) and were used for the estimation of property premiums (see Table 3 for descriptive statistics). Checks conducted on the representativeness of the sample on income, property value and EPC distribution can be found in Appendix A. Data on costs were obtained from the End User Costs Dashboard, a dataset developed by Nederlandse Organisatie voor toegepast-natuurwetenschappelijk onderzoek (TNO) and Planbureau voor de Leefomgeving (PBL). The two cost scenarios used, renovation to EPC B and D rating respectively are described in Appendix B. These costs are proposed as benchmarks for transitional plans at the municipal level and therefore offer a limited level of granularity at the level of the building typology and EPC certificate. Both of these scenarios are built around heat transition, this is a particularly pressing issue in the Netherlands since an overwhelming majority of dwellings are heated with natural gas. Heat transition poses a financial challenge since it may entail higher costs than natural gas (Rooijers & Kruit, 2018).

Finally, the changes in user costs result from renovation costs and increases in value determined in the model above. The user costs of capital calculations as per equations 9 & 10 reflect the variations in user costs under two policy scenarios. We define these scenarios following the literature presented in the policy background section. The first includes the current taxation benchmark and the ISDE subsidy, the second one incorporates a green dimension in the imputed rent taxation. The parameters are the same as those included in equation 2 except for ρ Vt which here reflects the green property premium resulting from the renovation and Tax, which includes the fiscal impact.

$$\text{User Costs Renovation Grant}_{(t+1)} = r \cdot V_t + \delta \cdot V_t - \rho \cdot V_t + RetExp - Grant + Tax \quad (4.9)$$

$$\text{User Costs Renovation Green Tax}_{(t+1)} = r \cdot V_t + \delta \cdot V_t - \rho \cdot V_t + RetExp + Tax \quad (4.10)$$

As the literature section on housing affordability has shown, the microsimulation of user costs is commonly used to disentangle the effects of taxation on households (Fatica & Prammer 2018). In this case, user costs of capital are a relevant tool since they elucidate the double reward of subsidising renovation for homeowners resulting from a direct cash transfer and asset appreciation through green premiums. These two scenarios diverge over the accounting for the financial incentive of renovation. On the one hand, the grant is a direct transfer and it is included in the user costs. In the green tax scenario, the renovation incentive takes the form of the Net Present Value (NPV) of tax saved over 15 years with a conventional discount rate of 0.06, similar to the one used by Bonifaci and Copiello (2018). Arguably, the NPV of a tax cash flow is less volatile than that of energy savings and more amenable to discounting. This incentive is included in the simulations of renovation financial viability in the next section. However, it is excluded from the user costs formula since this draws from accrual accounting implementing an asset approach to owner-occupied housing and does not incorporate directly investment decisions.

4.4 Results

4.4.1 Green Premiums: Analysis and Limitations

Table 4 shows the regression outcomes for the IV, OLS, and the first stage IV. The use of building age as an instrument holds since the F-statistic of the first stage is larger than 10. Also, the Wu-Hausman and Wald tests for weak variables are significant, rejecting the weak variable hypothesis (see Appendix C for details). The EPC change estimate doubles in magnitude in the IV regression, indicating that OLS underestimates this coefficient. Note that the results are log-level and should be interpreted as $\log Y_t = X\beta_t + \mu_t$, meaning that a one-unit change in X_t ($\Delta X_t = 1$) leads to a $100\beta\%$ change in Y_t. Following Angrist & Kolesar (2021), this paper adopts a just-identified approach, interpreting the estimator results as unbiased. The estimated 3.7% property value uplift per EPC improvement aligns with previous literature, which finds EPC premiums ranging from 2.2% to 6%, depending on the country and dataset. One of the main limitations of this approach is its assumption of linearity, which may lead to the underestimation of EPC effects in extreme cases.

A second limitation of these estimates results from certain features of the WoON dataset. WoOn consists of a cross-sectional dataset which is not amenable to some hedonic pricing analysis drawing from repeated sales data. A final limitation derives

TABLE 4.4 Regression Coefficients

	Dependent variable:		
	log(€/Sqm)		EPC
	IV (1)	OLS (2)	OLS (3)
EPC	−0.038***	−0.019***	
	(0.002)	(0.001)	
Cohesion	0.011***	0.011***	0.006**
	(0.001)	(0.001)	(0.003)
Urbanisation	−0.113***	−0.118***	−0.018**
	(0.002)	(0.002)	(0.007)
Municipality	0.024***	0.022***	0.004**
	(0.001)	(0.001)	(0.002)
Building Type	0.004	0.004	0.018**
	(0.003)	(0.003)	(0.009)
Region	−0.041***	−0.037***	0.005
	(0.001)	(0.001)	(0.003)
Building Age			−0.503***
			(0.004)
Constant	8.040***	8.007***	4.896***
	(0.013)	(0.011)	(0.041)
Observations	22,913	22,913	22,913
R^2	0.270	0.260	0.463
Adjusted R^2	0.270	0.260	0.463
Residual Std. Error (df = 22906)	4.958	0.332	1.198
F Statistic (df = 6; 22906)		1,341.519***	3,297.518***
Note:			*p<0.1; **p<0.05; ***p<0.01

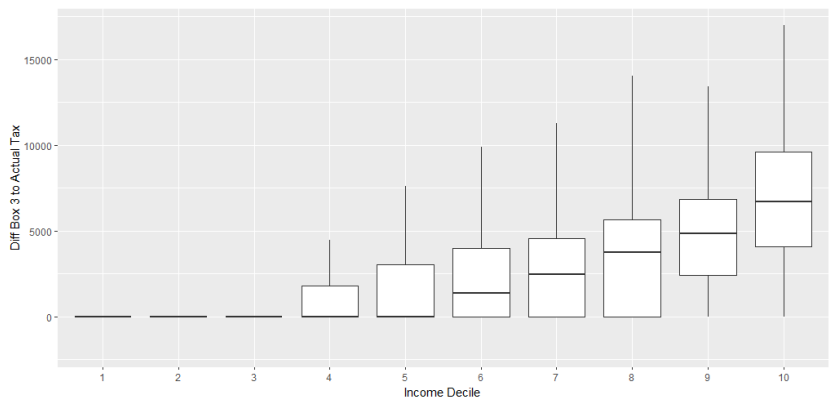
from the static estimation of a single parameter relating to property valuation and EPCs. The rise in property value is a mixture of substitution and income effects, from energy savings capitalised in the value of the dwelling. The shift toward a more energy-efficient built environment is also likely to lead to supply and demand shifts that affect equilibrium prices not captured by an IV analysis of this type. While Copiello and Donatti's (2021) model is static, changes in property valuation resulting from subsidisation are likely to affect value through second and third-order effects which are treated more in-depth in the discussion section.

4.4.2 Distributional Impact and Financial Viability of Housing Renovation

1) What are the distributional impacts of current and green imputed rent taxation compared to a tax-neutral benchmark?

This section tackles first the distributional impact in the fiscal burden under the three different taxation benchmarks presented in Table 2: Current Tax, Box 3: Tax Neutrality and Green Tax. Second, we focus on the viability of renovation in two scenarios: subsidy and green tax. Finally, we present the distributional impact of user costs and other indicators in those cases where the renovation is financially viable.

FIG. 4.2 Pecuniary Difference Between Tax Neutral Benchmark and Current Imputed Tax, as per Table 2, Across Income Deciles

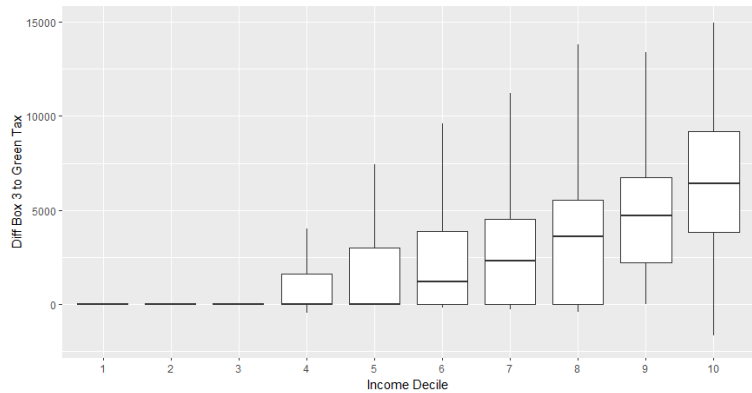


Source: Prepared by the author.

The comparison between current imputed rent taxation and a tax-neutral benchmark shows how the current fiscal policy favours the three highest deciles, see Figure 3. This is a result of the unequal distribution of owner-occupied housing which is

concentrated in the highest income deciles making the under-taxation of owner-occupied housing regressive. The tax-neutral benchmark, taxation of income from housing as that of any other financial asset, would increase the average contribution of those on the highest income decile by 1250€a year. In the highest quartile it could result in increases above 2500€. On the contrary, the first deciles have an average change of 0 since renting is more common among these groups. As shown in Figures 3 and 4, the impact of introducing a green dimension in housing taxation would fall also on the highest five income deciles. However, green taxation would only produce small redistributive effects over the current fiscal policy. A minority in these middle to high-income groups would see its tax fall marginally, while a majority would see small increases up to €500 per year. While green taxation does not have the redistributive reach of tax neutrality, its average impact over the first income deciles remains 0 due to the unequal distribution of owner-occupied housing. As a result, the limited increases in housing costs would only take place in the highest-earning half of the population.

FIG. 4.3 Pecuniary Difference between Tax Neutral Benchmark and Green Tax, as per Table 2, Across Income Deciles

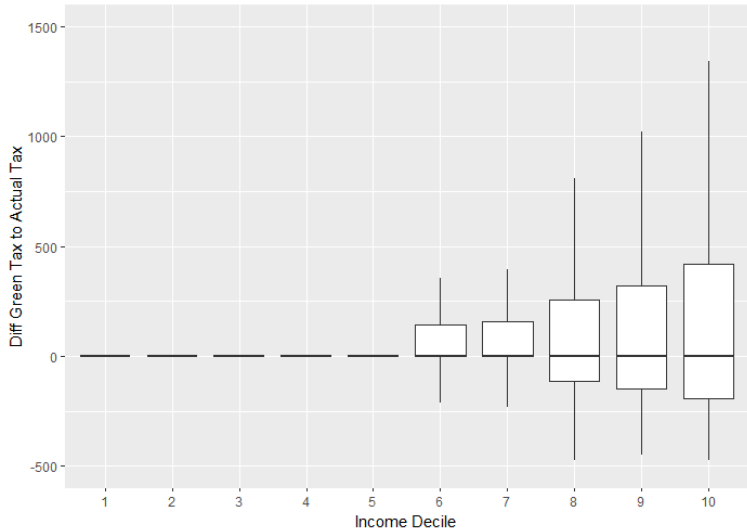


Source: Prepared by the author.

2) How do subsidies and green taxation affect the financial viability of housing renovation?

Figure 5 schematically represents Copiello and Donati's (2021) model of marginal benefits and marginal costs. This graph uses the data presented above on costs and premiums drawing from the simulated renovation of units included in the WoON dataset. The introduction of subsidies reduces the marginal costs and increases renovation viability; however, these also carry a certain deadweight loss. A green tax incentivises the financial viability of renovation by increasing the marginal benefits through the reduction of future tax obligations. In this scenario, the equilibrium point for renovation is where the MB line intersects with the "MC with subsidy" line. Conversely, it is the intersection of "MB with the green tax" and the Marginal Cost that points to the equilibrium in the green tax scenario. The green tax scenario is

FIG. 4.4 Pecuniary Difference between Current Tax and Green Tax, as per Table 2, Across Income Deciles



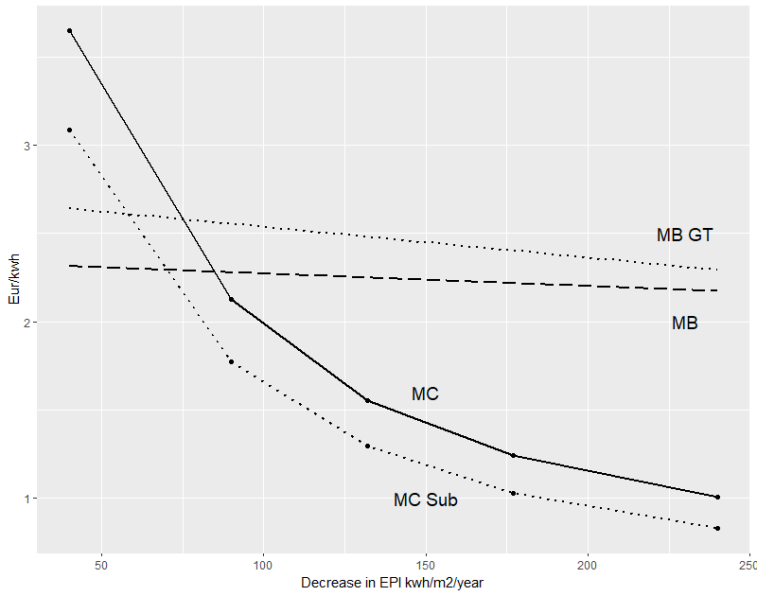
Source: Prepared by the author.

marginally higher which points to the renovation taking place also at higher property values in the Green Tax scenario.

As previous studies have showed (Copiello & Donati, 2021), the higher improvements in energy performance have the lower marginal costs. The density plots in Figure 6 (subsidy) and 7 (green tax) indicate that upgrading from EPC C to B, which would reduce the EPI by 40 on average, is often not feasible because the costs outweigh the benefits. However, for more extensive renovations with larger EPI reductions, marginal benefits are likely to exceed marginal costs. For instance, when renovating from E to B, the EPI is reduced by 240 and the benefits of renovation surpass the costs.

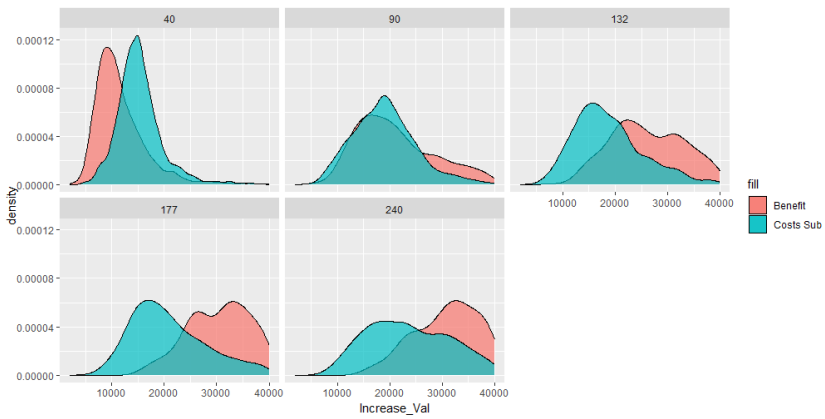
A comparison between the green tax and subsidy scenarios based on the reduction in EPI is shown in Figures 6 and 7. They reveal the similar effects of these policies on the viability of renovation from two angles: costs for subsidies and benefits for taxes. The overall changes in renovation viability are displayed in Figures 8 and 9, which also indicate minor differences between the two scenarios. However, Figure 9, which shows the renovation to D, suggests that green taxation has a smaller impact on renovation viability than subsidisation. This is because green taxation depends on energy performance rather than renovation costs. As explained in Table 2, green taxation aims to promote deep renovation to a high energy efficiency standard. Therefore, the post-renovation tax rebates are proportional to the EPC improvements, which lowers the feasibility of small-scale renovations.

FIG. 4.5 Schematic Representation of the model- Renovation to EPC B. Marginal Costs (MC), Marginal Costs with Subsidy (MC SUB), Marginal Benefit (MB), Marginal Benefit with Green Tax (MBGT)



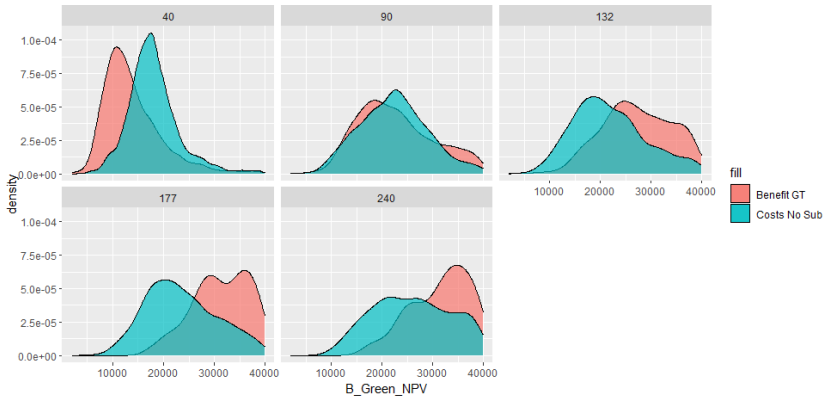
Source: Prepared by the author.

FIG. 4.6 Density Plots By Decrease in Energy Performance Index for Subsidy, all dwellings to label B



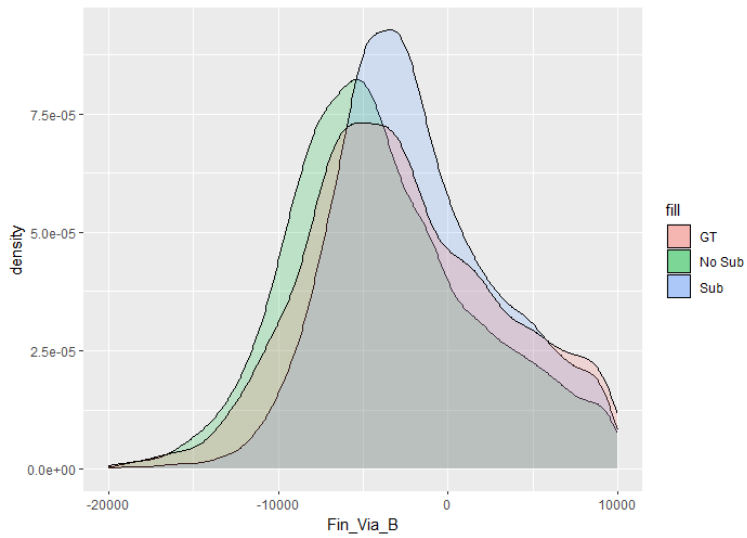
Source: Prepared by the author.

FIG. 4.7 Cost and Benefit Density Plots By Decrease in EPI for Green Tax all dwellings to label B



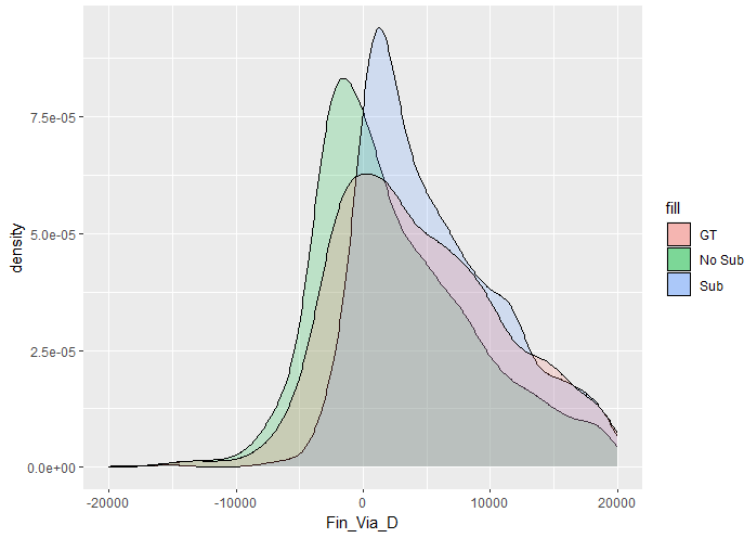
Source: Prepared by the author.

FIG. 4.8 Viability of Renovation to EPC B, with green tax (GT), with subsidy (Sub), without any subsidy (No Sub)



Source: Prepared by the author.

FIG. 4.9 Viability of Renovation to EPC D, with green tax (GT), with subsidy (Sub), without any subsidy (No Sub)



Source: Prepared by the author.

3)What are the distributional impacts of subsidy and green taxation scenarios on housing costs?

The effect of financially viable renovations on user costs is shown in Tables 5 and 6 for the two scenarios. Table 5 shows the user cost reduction for renovations to EPC-B with a subsidy. The reduction is higher for the lowest and highest income groups, and lower for the middle-income groups. This creates a U-shaped pattern. However, the total amount of subsidy is not distributed equally. It increases with income, which means that most of the subsidy goes to the well-off homeowners, while only a few low-income homeowners benefit from lower user costs. In the green tax scenario, the reduction in user costs exhibits a more pronounced U pattern, with higher reductions among lower-income deciles than those in deciles 8 and 9. However, the total Net Present Value (NPV) of renovation in the green tax scenario progressively increases the viability of investment among higher-income segments through tax savings. Consequently, the higher NPV rates together with the lower user cost reductions point to the untapped potential of green taxes to increase renovation rates without reinforcing the under-taxation of owner-occupied housing, shown in Figures 2 and 3.

Figure 9 shows that the viability of renovations to EPC-D is lower in the green tax scenario compared to the subsidy scenario. Despite this overall difference in viability, Table 6, like Table 5, presents a similar U-shaped pattern in user cost reductions for both subsidy and green tax scenarios, with total subsidies and NPV amounts growing with income. While green taxation seems to be more effective in increasing the

TABLE 4.5 Distributional Impact Renovation to EPC-B

Income Decile	Income	UC Subsidy	Total Subsidy	UC Green Tax	Total Green Tax NPV
1	11353.92	-17893.54	328195.01	-16137.30	233912.27
2	18307.17	-15876.90	361035.36	-14427.05	245837.60
3	23034.88	-10904.34	457995.65	-8731.57	338598.50
4	27576.93	-11323.55	786638.38	-9006.98	605272.18
5	32564.50	-11706.50	1051520.39	-9451.40	1003847.06
6	39096.07	-13448.87	1380218.38	-10709.19	1093726.77
7	47036.11	-13527.47	1344926.32	-10649.04	1250894.59
8	55911.36	-15258.20	1886719.15	-11605.74	2294599.97
9	67155.51	-17387.97	2084683.96	-12975.87	2906675.20
10	114414.38	-31902.11	3527930.52	-27380.69	8066170.28

viability of larger renovations, both simulations underscore the redistributive capacity of green taxation. Green taxation incentivises renovation by enhancing its benefits instead of subsidizing its costs, thereby mitigating the regressive distributional effects of current fiscal policy.

4.5 Discussion and Policy Implications

This paper contends that housing renovation policies ought to be conceptualised within housing subsidisation and taxation frameworks to grasp more comprehensively their distributional consequences on affordability and housing costs. Our analysis hinges on two points, first the estimation of energy efficiency premiums and, second, the calculation of user costs to assess the distributional impacts of housing renovation. This paper has followed Copiello and Donati (2021) in its departure from the usual DCF model used to assess renovation viability. Research based on the DCF model usually focuses on energy consumption patterns and assesses the viability of renovation based on energy savings. Using an asset approach allows to circumvent the discounting of energy savings therefore reducing arbitrariness in the election of a discount rate.

Our results show that renovation policies based on subsidisation reinforce the homeownership bias present in the current Dutch fiscal policy. The key policy takeaway is that green taxation offers possibilities to increase the financial viability of renovation and mitigate regressiveness in housing taxation. This is accomplished by mobilising untaxed housing income towards renovation. Conversely, the regressiveness of housing renovation subsidies is a result of home ownership being concentrated among taxpayers with higher incomes. As shown in the prior section, incentivising renovation through a green tax is overall more redistributive than through subsidies. This is in line with the proposals of Muellbauer (2018) and Davis et al (2017). However, compared with a fully tax-neutral benchmark a green tax has a more moderate distributive effect (Haffner & Heylen, 2011). Ultimately, imposing the same treatment to imputed rental income and other forms of income from wealth, thus eliminating homeownership bias, would require a much deeper rearrangement of the fiscal burden than the introduction of an energy efficiency element in imputed rent taxation.

The findings of this study also resonate with a recent OECD report which has highlighted the need to account for heterogenous taxpayers according to tenure (Millar-Powell, 2022). Renovation subsidies are targeted more strongly towards homeowners than renters. This could lead to regressive outcomes in countries where property ownership is concentrated among higher-income households. However, renovation viability has impact on both households' balance sheets and cash flows.

TABLE 4.6 Distributional Impact Renovation to EPC-D

Income Decile	Income	UC Subsidy	Total Subsidy	UC Green Tax	Total Green Tax NPV
1	11353.92	-13067.78	213810.48	-8222.67	50098.59
2	18307.17	-11265.61	295060.24	-10646.09	73005.68
3	23034.88	-7766.16	307474.77	-7554.91	64910.31
4	27576.93	-7662.90	550587.57	-4551.73	125172.98
5	32564.50	-7950.67	721407.96	-6542.41	219127.43
6	39096.07	-9490.13	876040.78	-7575.13	198244.10
7	47036.11	-9958.65	843723.51	-7625.28	240437.42
8	55911.36	-11595.53	1165381.26	-9119.91	442932.10
9	67155.51	-12589.23	1250104.54	-9359.88	523015.40
10	114414.38	-26523.76	2125606.12	-21432.83	2025191.04

While tax increases incentivise renovation, they do not reduce up-front costs. However, the existing subsidised loans already enable the elimination of upfront housing costs. Thus, green-imputed rent appears as a complement to subsidised renovation loans incentivising reticent households. For instance, in France, zero-interest renovation loans boosted renovation rates in the first two years of their introduction, especially for low-income homeowners. However, the demand for these loans declined over time (Eryzhenskiy et al. 2022) highlighting the need for further stimuli. On a similar note, tax increases could pose affordability challenges for lower-income homeowners, the asset-rich income-poor. Although, as stated in the introduction, low-income homeowners in the Netherlands are unlikely to live in unaffordable housing, deferring the payment of imputed rent tax until the property is sold or inherited would ease this burden.

Taxing income from housing through imputed rent according to its underlying energy efficiency is also complementary to a transition based on increasing energy costs through carbon taxation. There are multiple forms of carbon taxation (Rosenow et al., 2023) and the multiple effects these produce are beyond the scope of this paper. However, when it comes to the Netherlands, the carbon tax embedded in energy prices has been identified as one of the leading causes of regressiveness in the Dutch fiscal system (Maier & Ricci, 2022). The introduction of green imputed rent taxation focusing on energy-consuming assets instead of on energy consumption has the potential to revert these regressive distributional impacts. Groh et al. (2022) argue that, in the German case, splitting a C02 tax between landlord and tenant may prove too low to overcome split incentives preventing landlords from renovating their properties. Ultimately, the introduction of taxation on landlords and imputed rent on homeowners shares a similar objective: by taxing revenue from a polluting asset, it incentivises its renovation.

One of the key limitations of this research stems from a simulation constrained to first-order effects. Although this type of simulation offers insights into the distributional capacity of taxation and subsidisation policies, these simulations do not account for long-term effects which are affected by portfolio adjustment decisions. For example, in the US, Poterba and Sinai (2011) have shown how the revenue raised through the phasing out of mortgage interest deductions is highly contingent on portfolio decisions resulting from behavioural adjustments. A green tax is likely to have ripple effects diverting capital from real estate into other sectors. While this could accentuate green premiums, disinvestment into real estate could affect overall valuations ultimately having an impact on renovation viability. A structural equation model would serve to disentangle these effects. A more complex model of housing, following the likes of Skinner (1996) and Berkovec & Fullerton (1992), can help elucidate second-order dynamics related to affordability and consumption. A similar issue is highlighted by Figari et al.(2019), while the taxation of imputed rents increases homeownership costs, this inequality-reducing effect may be lower after portfolio and market adjustments. While in silico simulations allow for the comparison of ideal models, it is key to contextualise these findings within the literature on ex-post policy evaluation. In this regard, Neveu and Sherlock (2016) point out that tax credits for residential energy efficiency are inequitable in the US context since lower incomes or those already benefitting from deductions receive a lower benefit

than those with a higher tax liability. This paper points again to the regressive effects of tax cuts and subsidies resulting from the uneven distribution of homeownership.

Another limitation in our approach is the absence of explicit decision-making processes in renovation choices. While we show that the theoretical financial viability of renovation changes little under the green tax scenario with respect to the subsidy one, decision-making processes are much more complex. It is beyond the scope of this paper to assess the behavioural reactions to these policies. However, reactions to taxation and subsidisation have been studied from an array of perspectives (see for example Chetty et al., 2009). When it comes to housing renovation, the discounting approach coupled with behavioural theory has been most widely used to shed light on individual households' decision-making processes (see for example Ebrahimigharehbaghi et al. 2022). The findings presented in this paper aim to complement the analysis of individual decision-making by interrogating the overall distribution of housing user costs.

Together with the limitations in its behavioural dimension, this paper is also constrained by the limited granularity in cost data and fabric interventions. Consequently, user behaviour and actual energy consumption after renovation are beside the issues of housing appreciation and distribution explored in this paper. McCoy and Kotsch (2021) have shown that building conditions are likely to impact the redistributive effects of housing renovation. As shown by Brom et al., (2019), user characteristics after renovation are also an issue when it comes to energy savings. Moreover, energy efficiency improvements are not necessarily correlated with energy savings following the rebound and prebound effects identified for example by Sunikka-Blank and Galvin (2012). These effects could result in asset appreciation also being joined by increases in costs for future occupants. The decoupling of energy savings from property appreciation could impinge further on affordability, particularly in the case of renters.

Ultimately, this paper has aimed to problematise a model of housing renovation based on state-led asset appreciation through subsidisation and under-taxation. Under this model, it is asset owners, those with the higher incomes in the Dutch case, who stand to reap the main benefits of renovation while only covering a proportion of the costs. Green imputed rent, a similar model to that of Muellbauer (2018), offers a redistributive counterpoint further elucidated by assessing housing affordability through the reductions in user costs. However, this paper has estimated one key parameter and its results rely on simulations limited to first-order effects on viability and affordability. A more comprehensive analysis should interrogate renovation focusing further on welfare distributional analysis to assess the different policy options more comprehensively.

4.6 Conclusion and Recommendations

In conclusion, this study underscores the pressing need for adjustments in housing taxation and renovation policies to address the unequal distribution of housing costs in the Netherlands. Arguably, by focusing on energy efficiency gains, policymakers have remained oblivious to economic inequalities. As presented in the introduction, among OECD countries, Dutch renters spend on average the second highest proportion of their income on housing. Conversely, Dutch homeowners are the least likely to face affordability issues. Furthermore, the regressive outcomes of a carbon tax on energy and the under-taxation of home ownership impinge on the unequal distribution of housing costs. In this context, renovation policies carry the risk of further increasing the divide between homeowners and renters.

This paper's main takeaway is that green imputed rent taxation can make homeownership fiscality less regressive while concurrently incentivising renovation. Green imputed rent operates at the intersection of energy taxation and the progressive treatment of housing as a financial asset generating revenue. EPC-weighted imputed rent produces incentives for energy-efficient renovations by increasing their marginal benefits. Conversely, renovation subsidies increase renovation viability through cost reductions. These grants ultimately capitalise on property prices which further subsidise reductions in the user costs of owner-occupation, arguably one of the main drivers of housing affordability.

The introduction of green imputed rent taxation would marginally reduce the distortion of housing taxation from the tax-neutral benchmark, while enhancing the financial feasibility of renovations for homeowners. Rather than relying on additional state subsidisation, homeowners would be incentivised to finance the improvement of their dwellings themselves. Although this might be desirable from a renovation finance and equity perspective, it would impose a burden on the budgets of a large segment of homeowners. Hence, a key obstacle to the implementation of green asset taxation would be the social acceptability of homeowners' contributions. From an academic perspective, the analysis of renovation subsidies within the broader framework of housing fiscal policies reveals the potential for aligning social redistribution and environmental objectives. The taxation of energy-consuming assets instead of energy consumption itself offers a greater redistributive potential for housing costs. Such a redistributive shift might be crucial to address the disparities between homeowners and renters who are excluded from the value appreciation resulting from a renovation.

At the European level, tenure composition varies widely across countries, a factor that is likely to influence the effectiveness of carbon taxation and renovation subsidies. For example, the distributional impact of different renovation subsidies is likely to be very different in Southern and Eastern European countries where low-income homeownership is more common than in the Netherlands. Comparative approaches are instrumental in interrogating the potential of renovation policies and

formulating tailored approaches to each national context. While cross-country datasets like EU-SILC and tools such as EUROMOD allow for the microsimulation of housing taxation, the lack of comparable data for renovation costs and housing quality hinders the comparative analysis of "green" forms of housing taxation. As the EU and member states introduce Minimum Energy Performance Standards (MEPSs) in owner-occupied housing, more research is needed to interrogate the distributional outcomes of large-scale housing renovation. This requires a better understanding of second-order effects on property prices and portfolio decisions, as well as on consumption and welfare.

Finally, this paper has offered an initial investigation of the effects renovation policies can have on housing affordability. A contextualised approach is employed to account for the heterogeneity of households and tenures and to assess the costs and benefits of renovation for different groups. It is shown that renovation policies have differential impacts on housing affordability and may produce winners and losers in the decarbonisation process. Further research is needed to explore the distributional consequences of renovation policies and their interplay with other housing policies.

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PART 2 Finance and Provision

Part 2 explores the interplay between housing provision systems and policies, focusing on their design, implementation, and practical implications. The first chapter in this part adopts a political economy perspective to analyse homeownership subsidies in Croatia, focusing on their establishment, core targeting principles and impact on the housing market. Continuing with this logic of analysing the impact of housing policies on provision, the second chapter investigates sustainable finance legislation at the EU level and its influence on social housing finance across five Western European countries (France, The Netherlands, Denmark, Austria, and Germany). Drawing on the experiences of other European countries in building and managing social housing, the third chapter examines social housing provision in Spain through public-private partnerships (PPPs) highlighting specific financial challenges.

While these chapters address different policy domains—homeownership subsidies, financial regulations, and PPPs design and implementation—they share a qualitative methodological approach. Each chapter draws on its own set of semi-structured interviews complemented by descriptive statistics, with an emphasis on practical implementation issues. Also, these three chapters were written in close collaboration with non-academic partners: CERANEO in Croatia, Housing Europe in Brussels, and the Catalan Land Institute in Barcelona. Together, these studies provide insights into the implementation of housing policy, demonstrating the potential of bridging academic research and practitioner expertise to better tackle housing provision challenges.

5 The Role of Mortgage Subsidies in the Croatian Economic Growth Strategy

a political-economy approach to the SSK

Abstract [1]

Since 2017, Croatian housing policy has focused on promoting homeownership through the SSK programme – a form of mortgage subsidisation that covers a proportion of housing costs. Although this policy aimed to improve affordability and increase homeownership, a recent economic evaluation has shown that the SSK has in fact contributed to rising house prices and has been ineffective at raising the homeownership rate. While econometric research has identified the impact that the SSK has had on house price volatility and affordability, the underlying factors leading to the implementation of this subsidy, as well as its broader societal impacts, remain under-researched. Through a political-economy lens, this paper analyses the context that led to the inception of the SSK, its core targeting principles, and its impact on the housing market. We ask: How does this subsidy position the Croatian housing market within the national strategy for economic growth and social policy provision? We argue that this policy's impact on housing markets is twofold. First, the SSK reinforces a shift towards financialised growth through increased asset prices. Second, this subsidy shifts the focus of social policy towards mortgage markets, thereby furthering the privatisation of the welfare state and favouring middle-income groups. This paper's contribution resides in critically discussing the SSK beyond its stated goals and contextualising it within the broader model of economic growth dependent on private finance. Through interviews with relevant stakeholders, descriptive data indicators, and a review of policy documents, this paper characterises the Croatian growth strategy as a form of small-scale financialisation that relies on aligning social policy with mortgage markets. Finally, we position the SSK within a wider array of finance-led housing policies and suggest the formulation of a comprehensive housing strategy tailored to the broader segments of Croatian society.

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5.1 Introduction

In 2017, the Croatian Parliament introduced a new housing loan subsidy programme (Cro. Subvencioniranje Stambenih Kredita – SSK)[2] with the dual objective of increasing affordability and homeownership while also encouraging demographic growth. Using data from 2017 to 2019, a first evaluation of this subsidy's impact on the housing market identified the opposite effect – worsening housing affordability (Kunovac & Zilic, 2021). Using an econometric model, Kunovac & Zilic (2021) show how the SSK has resulted in recurrent house price inflation while failing to increase housing supply and homeownership rates. Their evidence suggests that the majority of subsidies have been concentrated in urbanised areas with already developed housing markets, rather than stimulating economic development in less dynamic regions, as originally intended. While this economic evaluation quantified the impact of the SSK on house prices and affordability, the underlying factors leading to the implementation of this subsidy, as well as its broader societal implications remain under-researched. Tackling them requires the problematisation of the role of financial markets in national economic development (Reisenbichler, 2020; Schelkle, 2012).

In recent years, the financialisation of housing markets has strengthened the links between housing policy, economic development, and inequalities (Aalbers & Christophers, 2014). Financialisation has been defined as 'the increasing dominance of financial actors, markets, practices, measurements and narratives at various scales, resulting in a structural transformation of economies, firms (including financial institutions), states and households' (Aalbers, 2019). Financialisation has generated a rich literature on the integration of housing finance and public spending in Western countries (see, for example, Fikse & Aalbers, 2021). In Croatia, financialisation has resulted in a set of predatory practices, such as foreign currency–denominated mortgages (Mikuš, 2020). During the last decade, the rise in Croatian house prices above European averages (1.A) has been accompanied by a new cycle of debt that raises questions about the risks of the current housing boom (Mikuš, 2022). In Croatia, political economy has served as an analytic lens for examining social protection policies that result in forms of clientelism and a familist welfare state (Stubbs, 2019). This political-economic approach to housing policy problematises mortgages and economic growth and thereby offers a relevant counter-perspective to that of the literature on housing regimes (Kemeny, 1981), which has tended to focus on the comparative analysis of countries in which tenures, such as the private rental sector (Bežovan, 2018), share similar characteristics.

Building on the political-economy approach to housing policy, this paper focuses on the context that led to the inception of SSK, its core targeting principles, and its impact on the housing market. Our objective is to link the literature on financialisation to specific features of the SSK's inception, implementation, and outcomes to examine its broader social and economic objectives. We ask the

[2] The subsidy was introduced by the Act on the Housing Loans Subsidies ('Zakon o subvencioniranju stambenih kredita' – ZSSK) (Official Gazette 65/2017, 61/2018, 66/2019 and 146/2020)

question: How does this subsidy position the Croatian housing market within the Croatian national strategy for growth and social policy provision? We argue that the impact of this policy on housing markets is twofold. First, the SSK reinforces a shift towards financialised growth by producing an increase in asset prices. Second, this subsidy shifts the focus of social policy towards mortgage markets which deepens the privatisation of the Croatian welfare state favouring middle-income groups.

To explore these issues, we first formulate an analytical framework that draws on existing literature, and we identify three key dimensions relevant to our analysis. The main empirical section then builds on these concepts to explore the Croatian context. We mainly draw from semi-structured interviews with relevant stakeholders, such as civil servants, estate agents, mortgage lenders, and academics. We also present secondary data from European and national sources. Furthermore, we include a review of policy documents and an analysis of parliamentary minutes. Finally, we conclude by contextualising the SSK and mortgage subsidisation policies within other finance-led growth strategies across Europe.

5.2 Growth Strategies and Housing Policy

A growth strategy, as defined by Hassel and Palier (2020) refers to a 'series of decisions and reforms, taken by either government or producers' groups (. . .) in order to boost growth and stimulate job creation in a specific national context' (p. 21). This concept calls for a contextual policy analysis that takes into account the economic climate that led to the adoption of a policy, while also considering the social and economic impacts beyond the immediate scope of the policy. Following this approach, Hall (2020) suggests that policies should be seen as part of explicit or implicit strategies that evolve in response to social issues while being embedded in a particular political understanding of economic issues. In this section, we draw on existing literature to identify three key dimensions that examine the role of housing in growth strategies.

First, investment in the housing market plays an instrumental role in finance-led growth strategies by increasing asset prices. Traditionally, housing development has been seen as a conduit for macroeconomic policy, as low interest rates and public spending increase demand and facilitate the creation of construction jobs during recessions (Piazzesi & Schneider, 2016). Hofman & Aalbers (2019) note that in the UK investment in existing properties has displaced new construction by the hand of policies that rely on finance-fuelled property markets for economic growth. More recently, Gil García & Martínez López (2023) contextualised the creation of an investor-friendly regulatory framework in Spain after the GFC as part of a broader strategy to increase asset prices and reignite property markets through the

privatisation of the social housing stock.

Second, social policies centred on homeownership and mortgage market subsidies amplify the role of housing as a financial asset. Howard (1997) made one of the first attempts to interrogate the subsidisation of homeownership through mortgage interest deductions. Schelke (2012) has argued that since the GFC, financial markets, and mortgages in particular, have become the preferred target of social policy either by fostering existing markets or creating new ones to facilitate access to credit. Easy access to mortgage debt is one of the key features of a finance-led system that allows households to support their consumption while it keeps asset prices high. However, as a result households are exposed exposing to increased borrowing risks (Crouch, 2011). This in turn can lead households to negative equity and foreclosures in the event of a market downturn (Mian et al., 2013). Building on the concept of growth regime and drawing on a Germany-US comparison, Reisenbichler (2020) points out how internal demand-led growth complements financialised housing policies, while export-oriented countries tend to be more conservative in their housing finance policies.

Third, subsidising homeownership boosts prices, which ultimately increases inequalities and worsens affordability. Across Europe, marketised and financialised homeownership policies have been criticised for their failure to deliver affordable housing, reducing access to homeownership and exacerbating price volatility (Arundel & Ronald, 2021). This contradiction between attempts to increase homeownership resulting in worsening affordability (Fikse & Aalbers, 2021), could be interpreted as an analogous process to the one identified by Kunovac & Zilic (2021) in their economic evaluation of the SSK described above. Ultimately, within Europe, transitional countries are dominated by systems based on homeownership, familism, and intergenerational solidarity (Stephens, Lux and Sunega, 2015). These features make them particularly prone to adopt financialised growth policies that rely on mortgage credit to stimulate the housing market.

5.3 A Politico-Economic Approach to the SSK

The following empirical section employs the three dimensions presented above to analyse the context that led to the formulation of the SSK, its core targeting principles, and its impact on housing provision.

5.3.1 A policy for finance-led growth: background and inception

After independence, homeownership came to occupy a central role in Croatia, as housing policy followed the path set by liberalisation in the West. The privatisation and residualisation of social housing through giveaways and right-to-buy initiatives led to an overreliance on ownership as the main tenure (Figure 1.E). In the first decade of transition, the number of public housing units public housing units decreased from 24% in 1991 to 2.6% in 2001, while homeownership increased from 64% to 82.9% (Bežovan, 2013). The 2000s saw a significant increase in prices and housing permits (Figure 2.C), as asset prices were boosted by a transfer tax exemption for first-time buyers, the expansion of mortgage markets, mortgage interest deductions, and subsidies for private rental households that continued to be provided until 2010 (Bežovan, 2019).

The GFC temporarily brought to an end the era of rising house prices. The credit market froze and, in the face of fiscal contraction, the limited public housing supply also declined, and the number of newly built dwellings plummeted as a result (Figure 2.B). The collapse of the housing and stock markets reduced the financial assets of a generation of Croatian households, while leaving a trail of stagnating property prices and unsold housing units. To reignite the housing market, the government devised a series of fiscal and subsidy measures, such as a state guarantee for the sale of unoccupied dwellings in 2011 (Bežovan, 2019). However, despite government efforts, the deep economic crisis had a long-term impact on the housing market and caused chronic stagnation in the number of both permits and completed dwellings that lasted until 2015 (Figures 2.C & B). It was in the context of earlier signs of mild recovery after stagnation that the SSK, the subsidy in question, was formulated.

The SSK Act states that mortgage subsidisation has two specific aims. First, it aims to improve housing affordability for younger households and increase homeownership rates. Second, it assumes a link between housing affordability and higher birth rates, which should ultimately lead to further demographic and economic growth. E-consultations and debates in Parliament during the adoption of this legislation and its amendments highlight some of the concerns raised at the time of the SSK's inception[3]. One of the main criticisms levelled when the legislation was being discussed was that the high income requirements meant only 10% of the population would be eligible for the subsidy and the legislation did not full take into account the ability to repay the loan after the subsidised period [4]. This critique calls into question the premise on which the SSK is built – namely, that an increase in debt and ownership among a broad household base will fuel economic and demographic growth. However, in the Croatian case, with only a small proportion of households being mortgage-eligible and a high proportion of outright homeowners, the SSK could only have a limited effect on homeownership rates, which in fact peaked in 2015 (Figure 1.B).

[3] See https://esavjetovanja.gov.hr/ECon/MainScreen?entityId=4492

[4] Phonogram from the parliamentary discussion of the reading of the 'Final bill on subsidising housing loans (link), second reading, P.Z. no. 126; 36, p. 19; Lovrinović, Ivan: '…only 10% of the young people working full time will be eligible to compete for this loan'. See https://edoc.sabor.hr/Views/FonogramView.aspx?tdrid=2013072

While the SSK builds on an international tradition of mortgage subsidies and deductions (e.g. Howard, 1997), its focus on asset-price growth rather than on access to homeownership is more blatant since Croatia already has extremely high rates of outright ownership (1.E). Effectively, the economic stimulus resulting from the SSK was limited to middle- to high-income households – those with access to asset markets. Sociological research on tenure structure and housing careers has shown Croatia's similarities to other Southern European states: a high degree of homeownership and family-backed housing provision centred on residential inheritance (Rodik et al., 2019). According to Lux, Hájek and Kážmér (2017), inequalities in housing tenure have been replaced by inequalities in residential wealth, making the value of residential property an important determinant of social inequalities and stratification. Ultimately, the SSK was ineffectively targeted as a result of the unequal income distribution, since the privatisation of the social housing stock had already turned a majority of households into homeowners.

The SSK legislation was also criticised proposing instead a reduction or exception from the 3% real estate transfer tax in the case of first-time home-buyers (Bežovan, 2019)[5]. Moreover, a higher subsidy amount was also proposed for applicants in the less developed parts of the country, which the government initially refused, but later accepted in an amendment to the legislation [6] Although the legislation that was adopted ultimately took into account geographical inequalities, its regressive targeting in terms of income was not amended. The criticism raised in parliament that characterised the SSK as an economic stimulus aimed at middle- and high-income households through mortgage markets is substantiated by the specific composition of housing tenures in Croatia and by the existence of fiscal measures geared towards housing price appreciation. At the time of its inception, the SSK was already being criticised for its contradictory design, which failed to reach people with lower incomes and ultimately relied on increasing debt among middle-income households to stimulate asset price growth. This will be covered in greater depth in the next section.

5.3.2 A social policy for mortgage markets: targeting and implementation

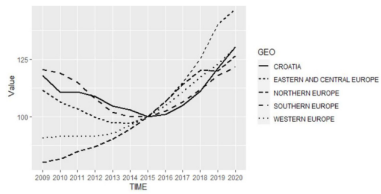
As outlined above, the SSK continues the traditional focus of Croatian housing policy on homeownership. At the time of its first round of implementation in 2017, the SSK's eligibility criteria required applicants to be no older than age 45 and to have successfully applied for a loan with a registered bank for the purchase or

[5] Phonogram from the parliamentary discussion of the reading of the final form of the bill on changes and amendments to the Act on Subsidising Housing Loans (link), urgent procedure, first and second reading, P.Z. no. 8668; 68: p.10; Selak Raspudić, M: 'first property tax … you will receive 3% from the State…'. See https://edoc.sabor.hr/Views/FonogramView.aspx?tdrid=2015139.

[6] Phonogram of the parliamentary discussion of the reading the final form of the bill on changes and amendments to the Act on Subsidising Housing Loans (link), urgent procedure, first and second reading, P.Z. no. 8668; 68: p.11; Selak Raspudić, M: '… the percentage of financing according to the development index is also questionable, since a higher development index requires a higher loan amount'. See https://edoc.sabor.hr/Views/FonogramView.aspx?tdrid=2015139.

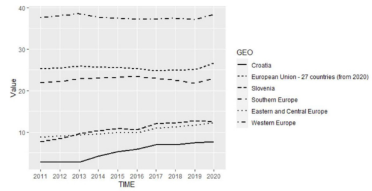
FIG. 5.1 Quantitative Indicators 1

Nominal House Prices (1.A)



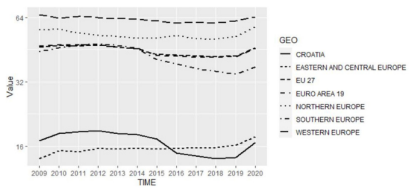
Source: Hypostat, 2021.

Share of Owners with a Mortgage (1.B)



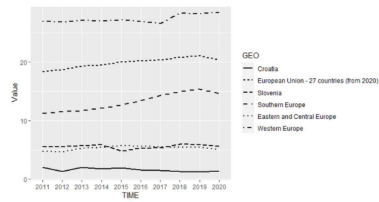
Source: EU-SILC, 2021.

Residential Loan to GDP Ratio (1.C)



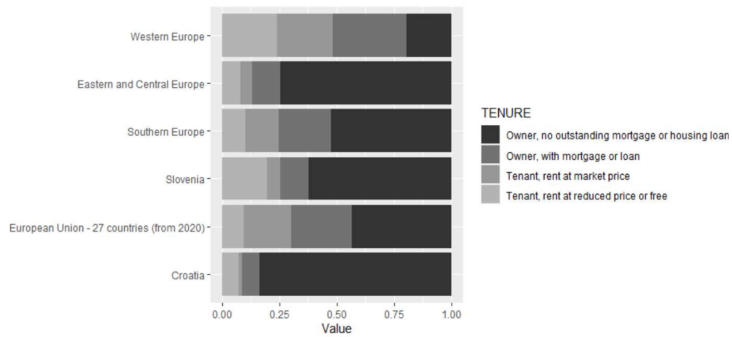
Source: Hypostat, 2021.

Share of Private Rent Tenants (1.D)



Source: Eurostat, 2021.

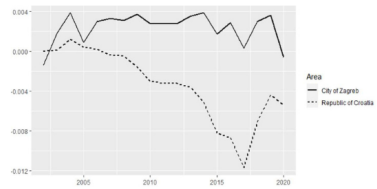
Tenure Breakdown (1.E)



Source: Eurostat, 2021.

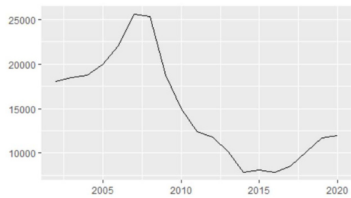
FIG. 5.2 Quantitative Indicators 2

Demographic Growth (2.A)



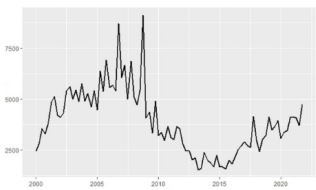
Source: CBS, 2021.

Completed New Dwellings (2.B)



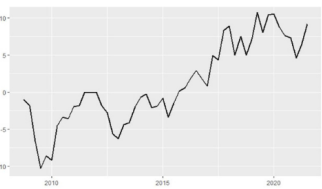
Source: CBS, 2021.

Number of Residential Building Permits Issued (2.C)



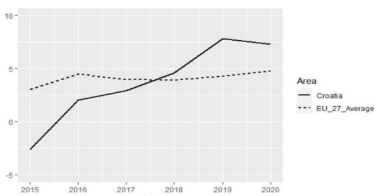
Source: HNB, 2021,

Price Growth Rate of Existing Dwellings (2.D)



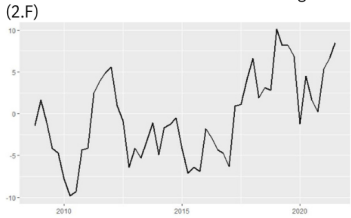
Source: HNB, 2021.

Average Growth Rate of House Prices (2.E)



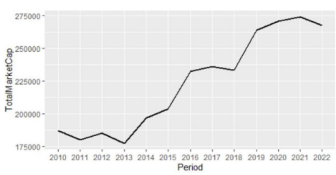
Source: Eurostat, 2021.

Annual Price Growth Rate of New Dwellings (2.F)



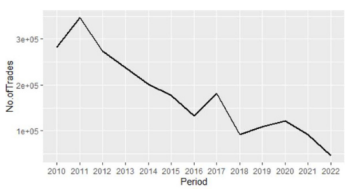
Source: HNB, 2021.

Stock Market Capitalisation Rates (Mil HRK) (2.G)



Source: Zagreb Stock Exchange, 2022.

Stock Market Number of Trades (2.H)



Source: Zagreb Stock Exchange, 2022.

construction of a property. The maximum subsidy was capped at 100,000 EUR and the maximum property price eligible was 1500 EUR/m2. The subsidy percentage was also capped at between 30% and 50% of the property's value, with less developed areas of the country being eligible for a higher subsidy percentage. Properties above the 1500 EUR/m2 threshold were still eligible, but the subsidy was only applied to the value below this amount. The minimum duration of the loan was 15 years and the Effective Interest Rate (EIR) during the first five years of its repayment could not exceed 3.75% per annum. The subsidy covered up to half the amount of the monthly instalments or annuities for the first five years. A special feature of the SSK is that, in contrast to other European countries, the mortgage subsidy in Croatia is not 'hidden' in a deduction, but takes the form of a direct payment (Kholodilin et al., 2022). Since this subsidy was designed to encourage demographic growth, households who had children in the five years after first receiving the subsidy had their subsidy extended for two more years per child. In addition, if a member of the household had a 50% or more disability, the subsidy was provided for one additional year. Finally, the SSK forbade recipients from renting out the home within two years of the end of the grant and the property had to be the recipient's registered home address. [7]

Noticeably, the SSK's eligibility criteria are remarkably high in its upper brackets for age and property value and effectively do not include any top income cap. Indeed, the subsidy was not even restricted to first-time buyers. Income requirements at the lower end are set indirectly through bank lending criteria and macroprudential policies that do not provide any favourable rates for lower- or single-income households. Macroprudential restrictions usually require a 25% debt-to-income ratio for average incomes, which can rise to 50% in the case of two-income households. In our interviews with the four major banks in Croatia, they stressed their confidence in the solvency of their borrowers. From the bank's perspective, these mortgages are a low-risk product as they are based on variable rates and are only accessible to middle- and high-income households. Moreover, the lack of a deed-in-lieu of foreclosure produces an uneven sharing of the risk between borrower and lender.

Our interviews with mortgage lenders also revealed the possibility of obtaining a mortgage of up to 100% LTV, as determined by national lending criteria. However, disparities between asking prices and bank valuations may lead to a lower mortgage amount, as one of the real estate agents we interviewed pointed out:

> Bank valuations are problematic since they are based on data from prior years and prices actually grow every day. A client asked a bank for a loan and was rejected because their valuation said it was too high but we know that that's the asking price from the market, the prices in the database are the ones that are low.
>
> — Real Estate Agent, 2022

This suggests that the pace of house-price growth is actually outstripping projections by bank valuations, a phenomenon directly attributed to the SSK by Kunovac & Zilic (2021). By focusing on ownership with a mortgage as the preferred tenure, the SSK

[7] Zakon o subvencioniranju stambenih kredita (Act on the Housing Loans'[Credit] Subsidy), Official Gazette 65/2017, 61/2018, 66/2019 and 146/2020.

indirectly targets those in middle- to high-income brackets. In its implementation, this creates two contradictions: on the one hand, the lending criteria shift the risk towards beneficiary households and, on the other hand, it is sellers, outright owners, and landlords that benefit from increased property prices. While the Croatian housing market shows signs of mortgage-led financialisation, the absence of other actors such as REITS or practices such as securitisation, highlighted by mortgage lenders during our interviews, turns the Croatian example into a particular case of small-scale financialisation – an idea that will be developed in the next section.

In addition to its eligibility criteria, another key feature of the SSK's roll-out is that it is only open to applications during a specific period each year on a first-come, first-served basis. This produces a crowding of investment into the space of a few months because the subsidy application requires that there first be a mortgage offer from a bank. Consequently, there is a spike in market activity, producing erratic house price growth (Figure 2.D). As one estate agent put it, the application process for the SSK has the effect of periodically igniting the housing market:

> The SSK is disconnected from new buyers and does not create a new market but instead has an effect over the market as a whole (...). Since it is a time-scheduled measure, it produces disturbances when prices go up because for a moment it is a sellers' market. Every year prices go up and then they don't really come down, and the next year they go up again.
>
> — Real Estate Agent, 2022

This cyclical pattern provides insight into the relationship between asset appreciation and mortgage subsidisation. This observation was also shared by other real estate agents, who see their workload fluctuate throughout the year. This is exacerbated by a fiscal regime where taxes on rental income are very low and favour buy-to-let (Bežovan, 2018). The SSK pursues a selected investment approach, by targeting higher income groups, as explored by Stubbs on other social policy areas (2019), and it is thereby part of a financial growth strategy pushing middle- and upper-income households into overvalued housing. While those in lower income brackets are relegated to low-quality housing, higher income households with easy access to credit become the main risk bearers in this type of financialised growth strategy.

5.3.3 Unintended consequences? Unaffordability and financialisation

Ultimately, this growth strategy, which is dependent on real-estate demand, has resulted in capital being diverted from productive sectors. The SSK has strengthened the position of the housing market as one of the main loci of investment, which hinders the development of a mature financial market. As one real estate expert we interviewed put it:

> Croatians made a series of bad investments in the 2008 crisis. Households lost money in Potemkin-like villages and in the stock market. Stocks were a good option until 2008. Now, there is distrust of new construction and the stock market.
>
> — Real Estate Agent, 2022

Since 2015, the capitalisation of the stock market has increased moderately, although the number of trades has decreased (Figures 2.G, 2.H). In fact, Croatia's value of stock traded is low even by the standards of transitional countries (Figure 3). The growth of stock prices has also been sluggish, and the ownership share of income is still low (Eurostat, 2021). However, the annual price growth of existing dwellings has continued to increase steadily over time (see Figure 2.D). House price growth (Figures 1.A & 2.E) and accompanying unaffordability have been two of the key consequences of the SSK (Kunovac & Zilic, 2021). While the impact of the programme on house price growth was discussed during the debate on the most recent amendments to the SSK Act in 2020, these concerns were ignored in the final form of the bill that was adopted. [8]

Following Hassel and Pallier (2020), this pattern of house price growth, motivated by low-cost and accessible credit, serves to identify expansionary phases in domestic-led growth strategies. While new construction has been sluggish in line with the demographic trend (Figure 2. A & B), growth in existing house prices has been sustained and even outpaced growth in some areas of Western Europe (Figure 1.A). According to our interviews with real estate experts, this is the result of a combination of direct investment from tourism (Vizek et al., 2022), increased real estate purchases by foreigners, mostly other EU citizens [9], and accessible credit through government subsidies. As one agent remarked:

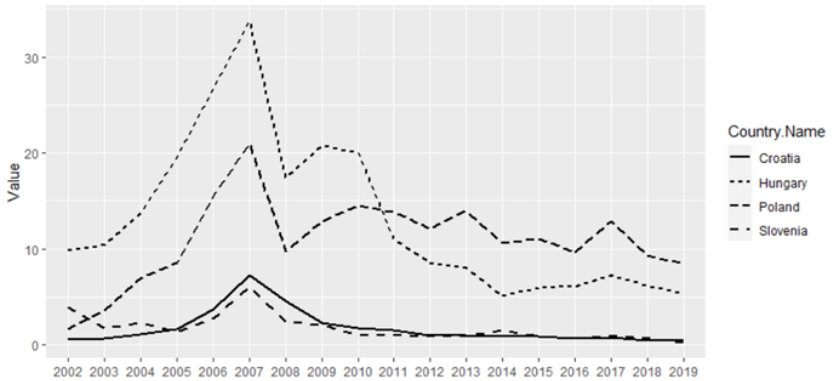
> New buildings and good buildings tend to be bought in cash much more often. 50% of the transactions I do are in cash, mostly income from tourism. Also, about 30% of my buyers are foreigners. Tax on renting is very low and capital gains are expected over 5 to 10 years so people wait before realising losses in a market downturn. Very different from the 2008 crisis where the new builds were being built and not sold. This time there's very little new build. (Real Estate Agent, 2022)
>
> — Real Estate Agent, 2022

SSK has contributed to an already unstable, investment-driven housing market. Ultimately, the increased house price volatility also has higher risk implications. In fact, drawing on research by the National Croatian Bank, the European Systemic Risk Board (ESRB) issued a warning in December 2021 suggesting that:

[8] Phonogram of the parliamentary discussion of the reading of the final form of the bill on changes and amendments to the Act on Subsidising Housing Loans (link), urgent procedure, first and second reading, P.Z. no. 8668; 68: p. 44, Tomašević, T.: 'we had 10% of real estate price increases in Croatia compared to 4.5% of the average increase in the European Union'. See https://edoc.sabor.hr/Views/FonogramView.aspx?tdrid=2015139.

[9] In 2021, German residents bought 2,637 properties in Croatia, which is an increase of 1,089 sales or as much as a 70% increase compared to 2020; Austrians made 1,109 purchases (472 more properties or an increase of 74% compared to 2020). Source: https://www.burza-nekretnina.com/svijet-nekretnina-savjeti/clanak-109-stranci-kupuju-sve-vise-nekretnina-u-hrvatskoj.

FIG. 5.3 Value of Stock Traded Croatia and Countries in the Region (% of GDP)



> a substantial share of new loans had a loan-to-value (LTV) ratio higher than 90% in the first half of 2021. Many of these loans, were government-subsidised loans, whose LTV ratios typically ranged between 90% and 100%. Approximately 10% of new loans had an LTV over 100%, while one-quarter of new loans were also granted with a loan service-to-income (LSTI) ratio over 40%. (ESRB, 2021 p. 3).
>
> — ESRB, 2021 p. 3

The ESRB identified the growth in household credit, the signs of overvaluation in the real estate sector, and the lack of borrower-based risk mitigation measures as some of the main vulnerabilities of the Croatian housing market. However, the warning also recognised that Croatian household indebtedness is low compared to other European countries (Figures 1.B & C) and highlighted the high capitalisation of Croatian banks. The economists we interviewed also pointed out that a major future shock could be related to a rise in interest rates, which will likely reduce the flow of money going into real estate and direct it into savings accounts. In the current market, where some units are overpriced, this poses a risk to developers and mortgagors, who may end up with negative equity. On the household side, the vulnerabilities of a potential market downturn seem limited to a small number of highly leveraged households. This reinforces the characterisation of the SSK as a form of small-scale financialisation driven by easy access to credit for well-off households, which fuels high property prices and locks up capital in real estate without stimulating new construction. The extent of the financialisation is also limited by the tenure composition of the Croatian housing system, which is dominated by outright ownership of housing as a result of the prior privatisation of the social housing stock.

5.4 Conclusion: the Contradictions of Domestic-led Growth through Household Debt

The evidence presented in this paper shows that the SSK has followed the path of similar finance-led growth strategies that rely on mortgage debt to fuel asset price appreciation. The Croatian context of very low to negative demographic growth (Figure 2.A) points to house price increases having ultimately been driven by investment and domestic debt than by changes in fundamentals. With the SSK, the government seems to be reinforcing a shift towards finance-led growth by fostering an alignment between social policy and mortgage markets. Ultimately, the mortgage market has become not only one of the main loci of investment, reducing the importance of the stock market and other productive activities, but also a main arena of social policy as the SSK effectively targets well-off households.

One distinct aspect of the Croatian case is that mortgage subsidisation is not 'hidden' in a deduction but instead takes the form of a direct payment. The SSK's eligibility criteria and its overall impact on the housing market of inflating prices demonstrate how social policy now targets middle- and upper-income households. However, this reconfiguration of the housing market has resulted in a contradictory shift of risk towards subsidised households, which is exacerbated by some of the specific lending conditions, such as the lack of a deed-in-lieu of foreclosure and variable mortgage rates. More broadly, while house price growth nominally increases the wealth of a majority of households, this only benefits downsizing households at the expense of those without assets, for whom it is then more difficult to acquire assets.

Finally, the SSK can be interpreted as a form of small-scale, state-led financialisation. It is a particular variant of financialisation that relies on subsidies and retail credit to increase economic growth in the absence of large institutional investors and fully fledged financial markets. This form of financialisation contrasts with that found in other southern European countries, such as Spain, where the privatisation of the social housing stock is what fuelled the post-GFC recovery (Gil García & Martínez López, 2023). The failure of the SSK to increase the proportion of households with a mortgage indicates that the price increases were driven by a minority of households with certain equity and higher income, for whom the SSK presents an opportunity to increase their housing wealth. This resembles the wealth-driven dynamics that Hochstenbach & Aalbers (2023) identified in the Netherlands.

Several specific changes to the SSK could lead to better outcomes – for example, better targeting of first-time buyers, lowering the eligibility age limit, using means-testing to define the top income cap, and accepting applications on a rolling basis. However, there is an urgent need for a national strategy to develop coherent housing policies that go beyond the current focus on homeownership. Instead of fostering a debt-fuelled growth strategy, as practised in the US (Schelkle, 2012) and the UK (Hofman & Aalbers, 2019), Croatia should formulate a needs-based housing

strategy. Such a strategy should include measures aimed at formalising the private rental sector, since the share of private tenants is extremely low by European standards (Figure 1.C), and at increasing the supply of social housing to achieve a more diverse tenure breakdown that caters to different income groups. For future evaluation purposes, a housing strategy should set clear, evidence-based targets and indicators and should have monitoring mechanisms to avoid the perpetuation of inefficient policies. While this paper has provided a critical qualitative analysis of the SSK, it has some important limitations. The lack of longitudinal data on the beneficiaries' finances means it is impossible to conduct an in-depth analysis of consumption and housing wealth or a robust statistical assessment of the demographic aspect of the SSK beyond its eligibility criteria. There is also a lack of qualitative research on the people who access the loans, i.e., 'lived experiences', which could elucidate the familial model this policy advocates through its nativist features. Finally, questioning the gendered and sexual identity dimensions of this subsidy can also lead to a critical interrogation of the family model that is being postulated at the intersection of finance and demographic growth.

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6 Three Contradictions between ESG Finance and Social Housing Decarbonisation

a comparison of five European countries

Abstract[1]

The regulation of financial markets according to Environmental, Social and Governance (ESG) criteria has become a priority for the European Union (EU). Recent legislation, such as the EU Green Taxonomy, aims to identify sustainable investments enhancing transparency and accountability while steering private finance toward environmental objectives. The introduction of ESG criteria poses specific questions for Social Housing Organisations (SHOs), particularly as the decarbonisation of the housing stock is also incorporated into national legislation. This article contributes to the social housing finance literature by breaking ground on ESG, an area of intensive legislative activity currently re-shaping financial markets. The study draws from interviews with SHOs' finance directors, banking officers, rating agencies and public officials to answer the question: How does the introduction of ESG legislation affect the financing of social housing decarbonisation? First, the results show that ESG legislation is broadening reporting responsibilities while producing only limited additional finance ultimately geared towards large and commercially oriented SHOs. Second, the expansion of energy-efficiency requirements is resulting in higher costs creating tensions with SHOs' social mission of building homes at affordable rents. Third, the adoption of ESG financing is producing inequalities in access to capital across national financing systems and individual providers.

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6.1 Introduction

In 2020, Clarion, one of the largest Social Housing Organisations (SHOs) in England, issued a record-breaking 15-year bond resulting in a 1.88% all-in rate. This is among the lowest interest rates that the sector had seen so far in the UK. Although English SHOs have become forerunners at raising private finance in capital markets since the adoption of the 1988 Housing Act (Whitehead, 1999), Clarion's bond was among the first underlined by adherence to non-financial indicators including high energy efficiency standards in new construction. According to Clarion's press release, the demand for the bond was strengthened by the SHO's accreditation as a Certified Sustainable Housing Label, an accreditation on corporate level for demonstrating Environmental Social and Governance (ESG) credentials. The label is issued by Ritterwald, a pan-European consultancy firm (Clarion, 2020).

Over the last decades, ESG debt issuance, through green, social or sustainability-linked loans and bonds has become increasingly common. Financial markets have hailed the adoption of ESG indicators as a tool to align capital investments with environmental and social goals, such as the decarbonisation of the social housing stock. According to the Climate Bonds Initiative (CBI), the green debt market has experienced a 50% growth over the last five years (CBI, 2021). However, the lack of clearly established indicators and objectives has tainted the growth of green finance with a series of high-level scandals and accusations of green-washing, unjustified claims of a company's green credentials. For example, a fraud investigation by German prosecutors into Deutsche Bank's asset manager, DWS, has found that ESG factors were not taken into account in a large number of investments despite this being stated in the fund's prospectus (Reuters, 2022).

To curb greenwashing and improve transparency and accountability in green investments, the EU has embarked on an ambitious legislative agenda. This includes the first classification of environmentally sustainable economic activities: the EU Green Taxonomy (Regulation 2020/852). When it comes to real estate, the accompanying Delegated Act (Regulation 2021/2139) introduced very specific criteria for green investments. New buildings should improve over national Nearly-Zero-Energy Buildings (NZEB) standards by reducing energy consumption a further 10% (Regulation 2021/2139). Regarding decarbonisation, the Taxonomy requires undertaking 'major renovations' as defined in the Energy Performance of Buildings Directive (EPBD) (COM(2021)) or reducing energy consumption for the final user by at least 30%. The Taxonomy is directly linked to the European Commission's decarbonisation strategy, the Renovation Wave (COM(2020) 662), which relies on a combination of private and public finance to deliver the investment needed for the decarbonisation of social housing. Energy efficiency targets have become increasingly stringent as the EPBD and its successive recasts (COM(2021)) have been incorporated into national legislation; see for example the French Loi Climate et Resilience (2021-1104, 2021). Consequently, capital expenses for SHOs are set to increase considerably. For example, in the Netherlands, according to a

Housing Europe (2020) report, attaining the 2035 energy efficiency targets set by the Dutch government will cost €116bn. Sustainable finance legislation constitutes an expansion of the financial measures implemented by the EU in the last decades to incentivise energy efficiency standards and renovations in the built environment, see Economidou et al., (2020) and and Bertoldi et al., (2021) for more detail on prior EU policies. It is because of the increased ties between finance and energy performance that the shift toward ESG poses particular questions for SHOs' access to capital markets.

The rapidly expanding finance literature on green bonds draws from econometric models to explore the links between investors' preferences and yields (Fama & French, 2007). This body of literature on asset pricing relies on the introduction of non-pecuniary preferences in investors' utility functions together with returns and risks to explain fluctuations in the equilibrium price of capital. Drawing from a comparison between green and conventional bonds, Hachenberg and Schiereck (2018) find evidence of the former being priced at a premium. Similarly, Zerbib (2019) also shows a low but significant negative yield premium for green bonds resulting from both investors' environmental preferences and lower risk levels. The European Commission's Joint Research Centre (Fatica & Panzica, 2021) documents the dependency of premiums on the issuer with significant estimates for supranational institutions and corporations, but not for financial institutions. While these econometric approaches offer relevant insight into the pricing of green bonds and the incentives for issuers and investors, they do not account for the institutional particularities of social housing, a highly regulated sector usually covered by varying forms of state guarantees and subsidisation (Lawson, 2013).

In the authors' understanding, this is the first article to approach the growing significance of ESG finance in social rental housing through a comparative approach across a set of North-Western European countries. A dedicated study of SHOs' finances and ESG in this region is particularly apposite since SHOs are responsible for the renovation and maintenance of vast swathes of the existing housing stock (OECD, 2020). This article draws from semi-structured interviews with finance directors, banking officers, rating agencies and public officials to answer the question: How does the introduction of ESG legislation affect the financing of social rental housing decarbonisation?

In the following section, this paper introduces the current legislative changes on ESG at the EU level. The next section briefly covers some methodological aspects of policy comparison and discusses the data collection approach. The fourth section constitutes the central empirical analysis and is structured around four research sub questions answered through a literature study and a qualitative data analysis. The fifth section discusses the findings positioning them within the existing literature. Finally, the sixth section concludes, offers policy recommendations and introduces questions for future research.

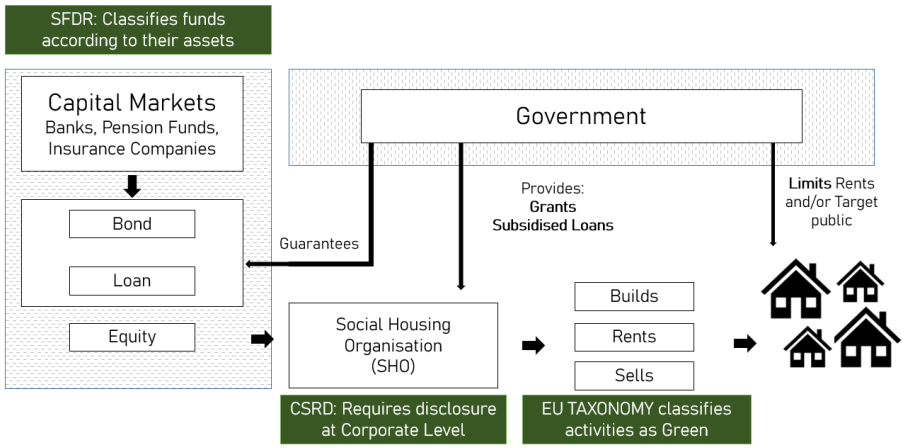
6.2 Policy Background: ESG and Decarbonisation

Throughout the last two decades, the term ESG finance has evolved to include a large number of financial vehicles of which green bonds have become the most popular (Cortellini & Panetta, 2021). In the social housing sector, ESG comprises a broad array of tools from sustainability-linked loans to less conventional forms of finance such as carbon credits [2]. When it comes to bonds, there is a wide variation in the sustainability credentials among the different types. Broadly speaking, green and social bonds are issued under specific 'use of proceeds', which means the funds raised must be used to finance projects producing clear environmental or social benefits. Issuance of these types of bond requires a sustainable finance framework which is usually assessed by a third party emitting an opinion on its robustness. Sustainability-linked bonds (SLBs) are an alternative to 'use of proceeds'. Funds raised in this manner are not earmarked for sustainable projects, but can be used for general purposes. SLBs are linked to the attainment of certain company-wide Key Performance Indicators (KPIs), for example an average EPC-C in an SHO's housing stock. These indicators and objectives usually result in a price premium for Sustainable Bonds, or a rebate in interest rates in the case of SLBs or sustainability-linked loans (SLLs) (Cortellini & Panetta, 2021).

While there are international standards for the categorisation of green projects such as the Green Bond Principle or the Climate Bonds Strategy, strict adherence is optional and there are few legally-binding requirements resulting in a large divergence in reporting practices and external auditing. To solve these issues and prevent greenwashing, the EU has been the first regulator to embark in the formulation of a legal basis for green finance through a series of acts targeting the labelling of economic activities, investors, corporations and financial vehicles. First, the EU Green Taxonomy (Regulation (EU) 2020/852) is the cornerstone of this new legislation since it classifies economic activities attending to their alignment with the objectives set in the European Green Deal (EGD). When it comes to housing, as presented in the introduction, the EU Taxonomy requires specific energy efficiency levels for a project to be deemed 'taxonomy aligned'. Second, the Sustainable Finance Disclosure Regulation (SFDR) (Regulation (EU) 2019/2088) mandates ESG reporting on funds, which tend to consist of exchange-traded collections of real assets, bonds or stocks. Funds are required to self-classify under article 6 with no sustainability scope, 'light green' article 8 which incorporates some sustainability elements, and article 9 'dark green' for funds only investing in sustainability objectives. Under the SFDR, which entered into effect in January 2023, fund managers are required to report the proportion of energy inefficient real estate assets as calculated by a specific formula taking into account the proportion of 'nearly zero-energy building (NZEB)', 'primary energy demand (PED)' and 'energy performance certificate (EPC)' (Conrads, 2022). Third, the Corporate Sustainability

[2] See for example Hact's "Retrofit Credits" or the French "Certificat d'Économie d'Energie

FIG. 6.1 Impact of ESG legislation, approved at the time of the interviews, on social housing financing



Source: Prepared by the author.

Reporting Directive (CSRD)(COM(2021) 189) increases disclosure requirements for corporations along Taxonomy lines. Also entering into effect in 2023, the CSRD will be progressively rolled out starting from larger and listed companies, expanding throughout this decade. Provisions have been made for charities and non-profits to be exempted. However, one of the key consequences of disclosure requirements over funds through the SFDR is its waterfall effect; that is the imposition of indirect reporting requirements as investors pass on their reporting responsibilities to their borrowers. Fourth, the proposed EU Green Bonds Standards (EU-GBS) COM(2021) 391 aims to gear bond proceedings toward Taxonomy-aligned projects and increase transparency through detailed reporting and external reviewing by auditors certified by the European Security Markets Authorities (ESMA). The main objectives of these legislative changes is to create additionality, that is, steer new finance into green activities (see Figure 1).

While this new legislation is poised to increase accountability and transparency, it also aims to encourage a better management of environmental risks. According to a recent report on banking supervision by the European Central Bank (ECB), real estate is one of the major sources of risk exposure for the financial sector (ECB, 2022). This includes both physical risks, those resulting from flooding or drought and, more relevant in this case, transitional risks, that is those derived from changes in legislation such as the EPBD and transposing national legislation. The ECB points to the need for a better understanding of risk transmission channels from real estate portfolios into the financial sector through enhanced data collection and better assessments of energy efficiency, renovation costs and investing capacity. At its most

extreme, non-compliance with EU regulations could result in premature devaluation and stranded assets (ECB, 2022).

The introduction of reporting and oversight mechanisms connects legislation on housing's built fabric, namely the EPBD, to financial circuits. On the one hand, the EU has been strengthening its requirements vis-à-vis energy efficiency over the last decades. The Energy Efficiency Directive (EED) suggested the introduction of Minimum Energy Performance Standards (MEPS) by member states (Economidou et al., 2020), a rationale followed by France and the Netherlands for certain parts of the housing stock. Furthermore, at the time of writing, it is being debated whether the EPBD's recast (COM/2021/802) may incorporate MEPS making decarbonisation an obligation for SHOs across the EU. On the other hand, legislation on green finance aims to produce incentives and oversight over investments in energy-efficient renovation and new build, mobilising the private sector to cater to green projects (Renovation Wave (COM(2020) 662)). This paper aims to identify and assess the changes that the introduction of ESG indicators is having on SHO finance by answering the following research sub questions:

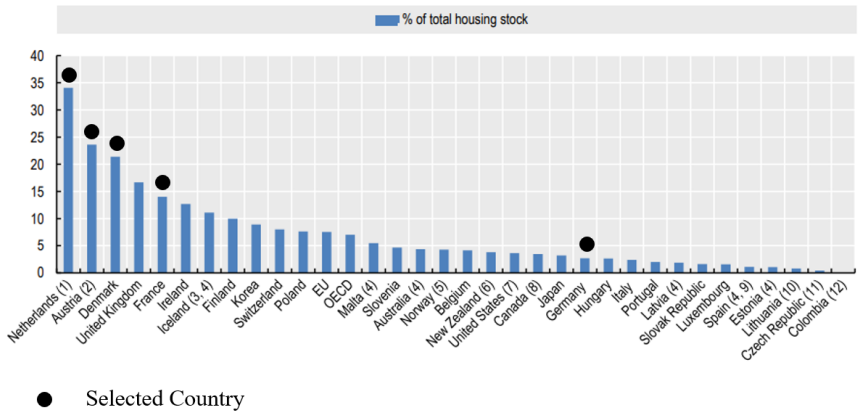
- What are the main underlying differences between social housing financing systems in Europe?
- How are reporting and disclosure obligations affecting SHOs' access to capital markets and ultimate borrowing costs?
- How are renovation requirements and Minimum Energy Performance Standards (MEPS) impacting SHOs' social objectives?
- How are national SHO management practices and organisation characteristics interacting with "greening" capital markets?

6.3 Methodology

Across North-Western Europe, SHOs are usually heavily regulated through rent-setting policies and governance standards. SHOs also have a long history of strong financial ties to the state, through public funds and grants, for instance Haffner et al. (2009). As a result, the capacity of ESG finance to produce additional investment and affect the cost of capital in the sector is deeply contingent on country-based institutional arrangements. While the comparative study of social housing finance from a social policy perspective is a well-researched topic, for instance OECD (2020), the exploration of bond finance in social housing has only been the focus of a few country-based studies; for example Wainwright and Manville (2017) in England. The literature on social housing green bonds is even more scarce

and, as far as the literature review has shown, limited to Mangold and Mjörnell (2022) for the Swedish case.

FIG. 6.2 Relative size of the social rental stock in Europe. Source: OECD Figure PH4.2.1



Source: OECD Figure PH4.2.1.

To explore ESG financing for social housing, this paper develops a qualitative approach inscribed in the housing studies literature to account for the particularities that differentiate social housing financing across national borders. Conceptually, it draws from a body of literature operating at the intersection between particularistic and universalist approaches. On the one hand, the particularistic view contends that housing phenomena can only be interpreted within the context of individual countries. In this vein, Ruonavaara (1993) argues that, for example, tenure should be seen both as ideal types and specific geographical and historical forms. On the other hand, the convergence or universalistic approach, as developed for example by Kleniewski and Harloe (1996) or Boelhouwer and Van der Heijden (1992), emphasises the translation of housing categories across contexts.

In dealing with particularistic and universalistic methodological differences, Haffner et al. (2010) compare the private rental sector from both perspectives and arrive at a compromise middle way that takes into account commensurability while cautioning for a contextual use of theory. More recently, Aalbers (2022) proposes focusing on 'common trajectories'. He argues for a focus on uneven development together with interdependencies between convergent or homogenising and, divergent or, heterogenising forces. As opposed to classification under ideal types, discussed above, this approach focuses on the dynamic forces at the intersection of state, finance and real estate shaping housing provision. Aalbers (2017) has also emphasised how changes in housing finance do not unfold coherently across widely heterogenous housing systems but through the production of tensions and contradictions.

TABLE 6.1 Breakdown of Interviewees by Sector and Country

Sector		Country	
Sector	**Number**	**Country**	**Number**
Consultancy	3	Austria	5
Sector Organisation-Federation	7	Denmark	5
Rating Agency	2	EU	4
Bank/Intermediary/Government	9	France	6
SHO	12	Germany	5
Total	33	Netherlands	8
		Total	33

Drawing on Aalbers (2022), this paper analyses the heterogeneising and homogenising forces shaping social housing financing as a consequence of ESG-related legislative changes. As a result, rather than generating a comprehensive classification, the research is focused on key regulatory changes and their impact on social housing financing landscapes. The policy background in Section 2 has identified three main homogenising forces resulting from the shift towards ESG finance: 1) reporting and disclosure obligations 2) renovation requirements and MEPS 3) "greening" of capital markets. While departing from the description of current SHO financing systems, this study focuses on identifying forces emanating from EU legislation that reshape these financing systems. The main objective is to account for the national particularities playing a role in explaining the varying degrees of incorporation of ESG into social housing finance. To answer the first research sub question, this paper analyses the existing literature on national social housing financing systems. Then, the qualitative approach consisted of thirty three in-depth semi-structured interviews across five European countries with large social rental housing stocks: France, the Netherlands, Denmark, Austria and Germany [3]. (Figure 2).

The selection of interview participants attended to saliency in two criteria. The first was organisation size, since mid to large SHOs tend to access capital from multiple sources to fulfil their complex financial needs. Second, in an attempt to control for SHO's legal status, participant selection also considered organisation's objectives (public/private; for-profit/limited profit) based on the specific regulations of each country. Initially, the interviews were geared towards SHO's treasury and sustainability managers. However, complex SHO's financing structures reliant on guarantees and subsidisation have resulted in the inclusion of credit rating agencies,

[3] In Germany, social rental housing is only considered as such while government subsidies are ongoing, see next section for detail. Even though the sector is small, Germany is included as a relevant case because of the existence of large landlords with high heterogeneity in their profit motivations facing renovation requirements.

public and private banks as well as public administration officials depending on the country in question (see Table 1). While the interview protocol was adapted ad hoc to the national context and type of agent, the questions covered the following topics: 1) business-as-usual, main investors and sources of finance, 2) role of ESG finance (bonds, loans) and reporting obligations, 3) financing renovation and energy efficiency requirements, and 4) risks, challenges and recommendations. Interviews were conducted between October 2022 and February 2023, mostly online but also in person at different Brussels locations. The interviews were recorded and the data gathered was coded in ATLAS.ti. Answers to research sub questions 2, 3 and 4 emerged from this coding process as the overarching themes structuring the cleavages across country and SHO lines (see Appendix A & B for methodological detail).

This qualitative approach complements that of the quantitative literature presented in the introduction. Instead of focusing on the identification of a green premium, the rationale behind ESG uptake through the institutional particularities identified in the literature and the first-hand experience of those involved in SHO debt issuance are explored. This approach aims to overcome the limitations of different green standards for debt-issuance together with current volatility in financial markets. These different standards overlapping over time complicate comparisons between regular and ESG bonds within the social housing sector. Even though this study draws on a substantial sample of interviewees and covers key stakeholders across SHOs of various sizes and financial situations, limitations inherent to qualitative research apply. For instance, while the questionnaire included discussions about the pricing of green and traditional capital, these findings are interpreted in dialogue with quantitative evidence.

6.4 ESG finance and the Decarbonisation of the Social Housing Stock

What are the main underlying differences between social housing financing systems in Europe?

This section draws from academic literature to identify the main features of the selected social housing financing systems. First, in the Netherlands, the transition from a government-provided grant to a guarantee fund [Waarborgfonds Sociale Woningbouw] (WSW) has pushed Dutch SHOs towards raising debt in capital markets (Boelhouwer, 1997). In its most extreme cases, liberalisation resulting from the end

of government grant subsidisation allowed SHOs to undertake riskier operations, namely speculation with derivatives. In 2011, the resulting losses amounted to €2.1bn for the largest social landlord, Vestia, which had to be covered by the WSW and ultimately Dutch SHOs (Elsinga & Wassenberg, 2014). Eventually, this proved the strength of the guarantee system which allows Dutch SHOs to borrow at a very low spread over sovereign issuance [4] with their debt rated triple AAA, as that of the Dutch state (S&P, 2022). Currently, most of the financing of SHOs comes from two public promotional banks, Dutch Local Authorities' Bank [Bank Nederlandse Gemeenten] (BNG) and Dutch Water Authorities Bank [De Nederlandse Waterschapsbank] (NWB), which lend on their own bond proceedings to SHOs (BNG Bank, 2021) (NWB Bank, 2021).

Germany followed a similar path to the Netherlands in which direct subsidies, used to lower the costs for tenants in both social and private renting, have been substituted by lower interest and subsidised loans by the public Bank for Reconstruction [Kreditanstalt für Wiederaufbau] (KfW) (Droste & Knorr-Siedow, 2014). However, these subsidies are temporary and result in the conversion of subsidised housing into private market units once the loans are fully repaid, particularly in the case of for-profit landlords. However, a number of SHOs, either publicly owned by municipalities and regions or charitable institutions, retain lower rents after the end of the subsidy period (Haffner, 2021). The concession system of German subsidies results in a very low proportion of social housing despite the existence of a large below-market rental stock in the hands of landlords with varying profit motivations (Kofner, 2017). Together with loans, larger SHOs have started to tap onto capital markets directly through bonds such as the one presented in the introduction.

The French social housing system is managed by a mix of Public Offices owned by local authorities and privately-run charitable housing companies. The state regulates their rents which are linked to the financing provided by the Caisse des Dépôts et Consignations (CDC), a public bank. Their long-term debt is usually guaranteed by local authorities or by the Mutual Fund for Guarantees of Rental Social Housing (Caisse de Garantie du Logement Locatif Social; CGLLS) (Schaefer, 2003). New construction is financed to a high percentage through different sets of loans issued by the CDC, with varying levels of subsidisation depending on the income of the targeted household (Tutin & Vorms, 2016). The remaining funding needs are covered by market loans and bonds, local authority equity and grants (Lévy-Vroelant et al., 2014).

The Austrian system is based on a combination of state subsidies and cost-based rents. This rent-setting strategy allows SHOs to recover the costs without adding a profit and jeopardizing housing affordability (Mundt & Springler, 2016). As a result, a revolving fund is created once the original loans are repaid, which facilitates constant reinvestment into new projects and maintenance by SHOs with remarkably high levels of own-equity. This system is backed by a set of low-interest public loans and to a lesser extent on grants implemented by the regional level of government (Kössl, 2022) (Kadi & Lilius, 2022). Austrian SHOs strongly intertwine the state and the

[4] A spread is the difference in yield between two bonds. The sovereign spread is the difference between any bond and that of a government with AAA rating.

banking system through subsidisation and de-risking allowing for a steady flow of capital from private banks and European sources such as the European Investment Bank (EIB) 2019).

Similarly, one of the key features of the Danish social housing system is the National Building Fund (LBF), [Landsbyggefonden]. LBF is financed by tenants' contributions after the main mortgage loan of a property is repaid. LBF's main mission is to mitigate the individual risks of SHOs offering loans and subsidies to SHOs undertaking renovations or new build projects (Blackwell & Bengtsson, 2023). As in the Netherlands, social housing financing has also shifted from public subsidies toward market loans (Norris & Byrne, 2021). However, these loans are framed within the heavily regulated Danish mortgage-bond market system [realkredit(-lignende) lan]. Since 2017, these bonds are issued through government financed guarantees (Lunde & Whitehead, 2016). This is beneficial to both the mortgage institutes, the bond issuers, since these bonds are exempt from capital requirements; and the housing providers since they access capital at a premium as investors are willing to pay more for government securities. The national bank acquires the securities issued in this way (Bindslev, 2018).

TABLE 6.2 Summary of Social Housing Financing Features

Country	Public Bank	Bonds (Own-name)	Bonds (Interme-diaries)	Reinvest. Fund	State Guarantee
Austria	No	One	Private	Yes	For govt. owned
Denmark	Regulated	No	Private	Yes	Common Fund
France	Yes	Yes	Public	No	Yes
Netherlands	Yes	No	Public	No	Yes
Germany	Yes	Yes	Public	No	For govt. owned

Summarising, to varying extents, these countries implement different forms of state backing or mutual sector guarantees that allow SHOs to tap into the private sector finance at advantageous rates (see Table 2). A comparative study by Lawson (2013) including France and the Netherlands, shows how these guarantees not only play a compliance and overseeing role, but are also key in de-risking and directing investment to SHOs at lower interests. Similarly, Whitehead (2014) highlights the strengthened role of private debt finance across a majority of European countries in the last decades. Noticeably, while bricks and mortar subsidies have been substituted by interest subsidies and loans to a certain extent across most countries, Austria and Denmark have retained revolving models which allow for the reinvestment of limited profits within the social housing sector (Scanlon et al., 2015).

How are reporting and disclosure obligations affecting SHOs' access to capital markets and ultimate borrowing costs?

Environmental disclosure obligations are a key feature of ESG frameworks, and they aim to lower capital costs for activities aligned with environmental objectives, as presented in section two. However, through grant funding and guarantees, SHOs already have access to very low interest-rate debt in most countries, particularly in France, The Netherlands, Denmark, and Austria, as Figure 3 shows in detail.

> The margin for the bank is EURIBOR plus 1.5 or 2% or swap rate + 1.5. If you have a fixed long-term fixed loan, it's a swap rate plus one 1.4 to 2%. In our sector, we are between the indicator plus 0.6 to maximum 1%, so our interest rates are between 0.5 and 1% lower than the rest, but already before ESG. This is coming out of the high equity portion and the low rent as we have no profit in the rent, and if we have a cost-based system our rents are around 30% lower than market rents. By these lower rents, we have no problem of renting out [homes] because anyway people come to us.
>
> — CEO, large SHO, Austria

Despite the lack of grants, the funding of Dutch SHOs presents similar characteristics to that of their Austrian counterparts through a state guarantee by the WSW. As a result, the greening of funding streams has a limited impact on SHOs' capital costs since these are already covered by the state guarantee, while Austrian SHOs have access to grants resulting in highly-rated debt.

> Investors like to invest in banks with green assets, green loans and products like that. The combination [SFDR & Taxonomy] formalizes this process (. . .). It's more reporting what you do, but it doesn't make a difference [in financing]. (. . .) I think that's reverse causality there [between ESG and reporting].
>
> — Finance expert, sector organisation, The Netherlands

These two testimonies raise questions on the additional value of greening existing funding sources and where additionality actually accrues: whether it is at the SHO, or the fund manager. A Dutch public bank already issuing social and sustainability bonds, see Figure 3-NL, also questioned the relevance of ESG granular reporting following the taxonomy indicators:

> How big is the reward for the punishment? I mean, in our market we have two public sector agencies, (. . .) and we are very much in competition on the lending side. So all our clients, they ask both of us a quote and then it really can be up to half a basis point difference. So when you look at sustainability linked, then you can say, well, maybe you should have a reward like 20 or 25 base points to make it substantial [green premium], but now I still think we have one or two [bps].
>
> — Bonds expert, public bank, The Netherlands

Since SHOs in both Austria and the Netherlands are highly rated, on account of their high equity in the case of the former and a strong public guarantee in the case of the latter, their debt issuance is highly aligned with that of the sovereign and hence only slightly susceptive to greening. Similar views were shared by interviewees at a

pan-European bank and several national institutions. This contrasts starkly with the taxonomy-aligned bond of a for-profit German SHO which reached a noticeable basis point premium:

> When we issued the bond, we got 10 basis point greenium. (. . .) We've issued more than 4 billion in green and social format. As a proxy, let's say 5 basis points of benefit, 'greenium'. That means annual savings of about 2 million.
>
> — Head of Treasury, large SHO, Germany

This points to a higher level of disclosure resulting from taxonomy alignment being rewarded by the market. However, as for-profit operators are usually not covered by public guarantees, they intrinsically stand to benefit from larger green premiums as their spreads are originally higher than those of state-backed SHOs. Further price differentiation between green and conventional state debt could impact the financial incentives for green debt issuance. However, this will depend on the balance between pressure on investors through the labelling of funds and activities, and the pool of green debt released not only by SHOs but also by the economy as a whole. As a result, tensions arise between ESG and SHO financing where increases in reporting responsibilities are not always met with lower interest rates. Going forward, the roll-out of SFDR and EU-Green Bonds Standard could produce tighter competition among investors. An Austrian bank with a large portfolio of social housing loans offers this reflection alluding to the roll-out of the SFDR which will impose disclosure at fund level:

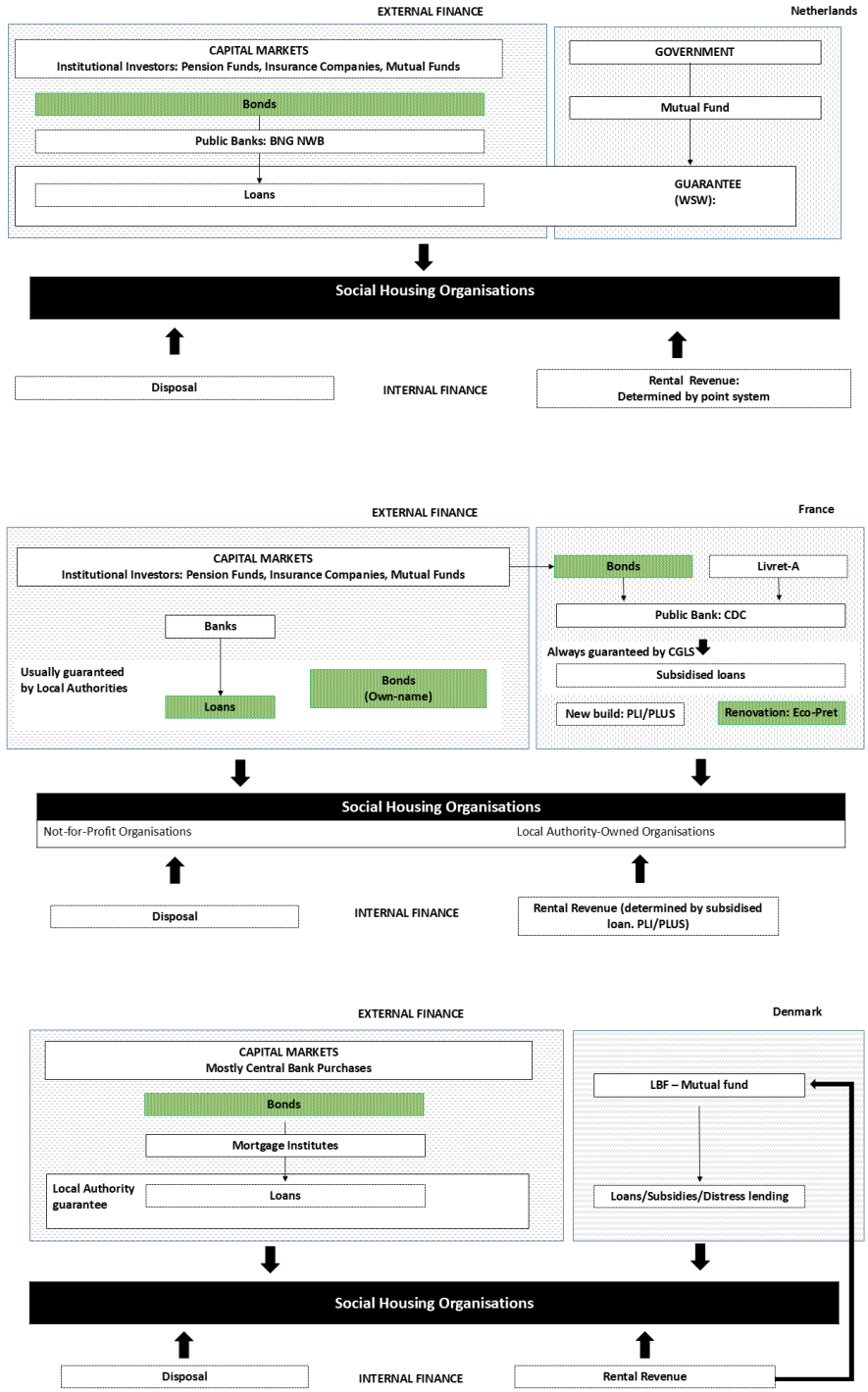
> At the moment, [Green Issuance] is not the way to get the cheap money and to provide it to social housing [. . .] When the first SFDR Reports are published, I think that this will be a new step for further input that could be traced in the funding. (Lending officer, bank, Austria)
>
> — Lending officer, bank, Austria

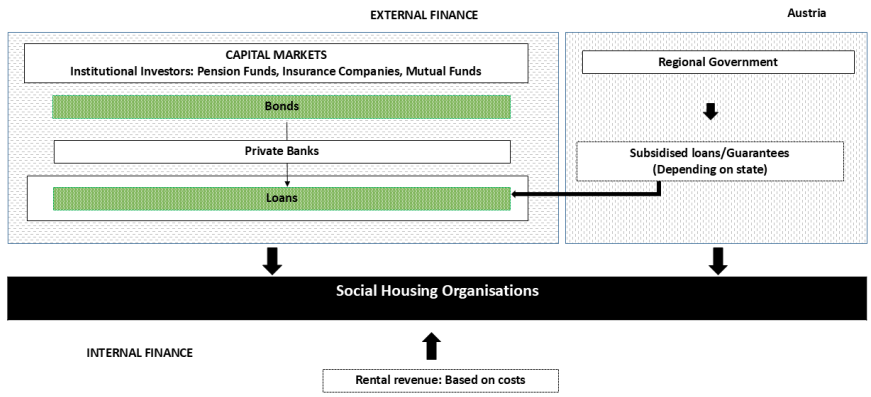
Ultimately, the introduction of environmental standards in a highly regulated sector may not materialise in lower interest rates for those already accessing capital at (be)low market levels due to their reduction of risk premiums through guarantees. However, it is not just a reduction in capital costs that is leading SHOs toward ESG financing. Decarbonisation pressures together with the introduction of broader standards across financial markets requiring enhanced disclosure is seen as "a new normal". Non-pecuniary advantages were also highlighted by most of the interviewees citing mainly access to a diversified pool of investors. For example, some of the interviewed public banks driving these changes see their work as market-shaping and standard-setting rather than motivated by interest rate reductions.

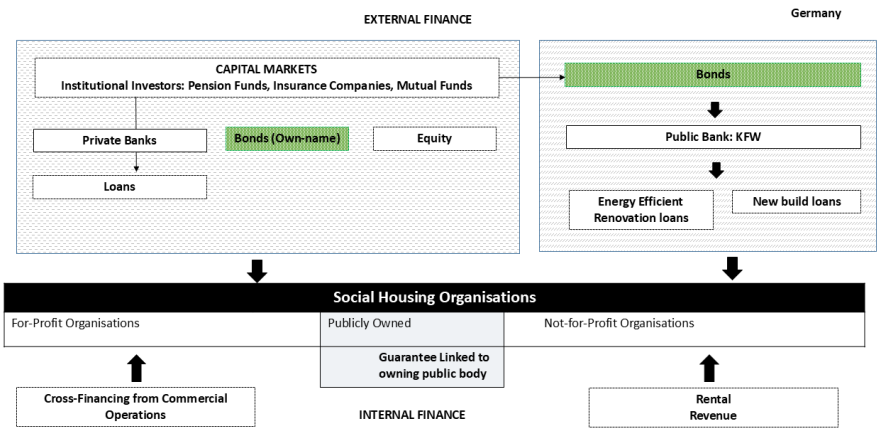
How are renovation requirements and MEPS impacting SHOs' social objectives?

The introduction of enhanced energy performance requirements at both EU and

FIG. 6.3 Greening of social housing finance by country. Source: Prepared by authors







Source: Prepared by the author.

national level is steering providers towards environmental objectives. However, increased leveraging for renovation is reducing the available resources to deliver on other social priorities.

> [SHOs] have to renovate their G dwellings right to be able to rent them out and this drives their CapEx Plans. The main ratio that we look at when we rate them is the net debt to EBIDTA ratio. In that, you have the CapEx included because they have to borrow for renovating their dwellings.
>
> — Associate Director, credit rating agency, France

Credit risk indicators, such as net debt to EBIDTA [5], measure leverage against assets and revenue and result in variations in capital costs. As energy efficiency requirements are engrained into national frameworks, SHOs on a less solid financial situation are having to renegotiate their debt. Although SHOs operate in a highly regulated environment with different forms of state-backing, their borrowing remains constrained by financial risk ratios occasionally leading to refinancing operations. As improving energy efficiency in the housing stock becomes a sine-qua-non criterion to access funding and decarbonisation deadlines are rolled out, SHOs have to compromise on other fronts. In the interviews, the most commonly raised trade-off has been new construction, as is confirmed by Housing Europe (2020). ESG finance, through the introduction of environmental reporting criteria for investors, is strengthening the centrality of renovation in SHOs financial plans.

Depending on national rules around rent-setting, renovation requirements produce split incentives, where SHOs have a new financial obligation without the expectation of return, as highlighted by rating agencies. The subsequent cost increase is compensated in some cases by rent increases or the introduction of 'warm rents' which allow SHOs to recoup their investment in renovation and partially circumvent the split incentives problem through rent rises.

In the Netherlands, different types of fees have been proposed to incorporate renovation costs into rents after deep renovations (van Hal et al., (2019). In France, SHOs use a particular form of 'warm rent' called 3rd receipt line [3ème ligne de quittance]: 'We do a 3rd receipt line by telling tenants we're going to isolate your building from the exterior. In exchange, you will have lower heating costs and conversely, we ask you to pay more in rent' (in French in the original). However, differences by provider apply. Another French provider implements a continuous rent-raising strategy to the legal maximum and highlights the need to balance renovation operations not at the level of building but at the level of the operator through cross-financing of internal resources, see also Joint Research Centre(2014) for a review of policies targeting split incentives. In Germany, renovation can lead to rent increases since after 30 years social housing can be reverted to market rates and rent remains controlled just through the national legislation.

> The last 20% of [energy] savings cost more than the first 80%. So for the last

[5] Net debt to EBIDTA is the ratio of liabilities to Earnings Before Interest, Taxes, Depreciation and Amortisation (EBIDTA) of a company.

> 20% if you go for that, you would have to increase the rent that much. That's not affordable housing and you would have to kick out your tenants. So that makes it [full energy neutrality] wishful thinking.
>
> — Director, sector organisation, Germany

Even in these instances, prior research has shown that recouping investments through rent rises may not be financially sound, as green premiums fail to compensate for renovation costs (Galvin, 2023) Depending on the national context, decarbonisation pressures and energy efficiency requirements are producing a trade-off decision between renovation, new construction and affordability. These trade-offs, while taking place at SHO level are not only contingent on company finances but have different implications across national financing systems. In Austria, state intervention has reduced the financial burden on SHOs through public subsidies combined with upper rent limits. Here, strong state intervention comes to join a particularly favourable situation since renovation is already anticipated in cost-based rent setting.

> The upper limit of the rent which they [SHOs] can ask when the subsidy is still going out is fixed. They can't go over this upper limit of rent. The kind of deal we have is, that we as a state give them money to renovate their buildings and achieve a certain level of energy efficiency. And what we get back as a state is, on the one hand, climate protection and, on the other hand, affordable rents.
>
> — Director, regional authority, Austria

Ultimately, SHOs have to balance out energy efficiency and new build investments as these are the two main components of their leverage ratios together with rental income. According to the ECB (2022), decarbonisation costs are a key transitional risk for real estate asset holders as these impinge on values. The EPBD, through renovation requirements, and the ESG legislation, through disclosure obligations, are embedding the transitional risks derived from decarbonisation obligations into SHOs capital expenditure plans. State guarantees and redistributive mechanisms, depending on the country, mitigate the transitional risks derived from changes in asset valuation resulting from renovation requirements.

> We have this guarantee and it doesn't really matter how high is the risk profile for a corporation or how green it is. At this moment, it doesn't really matter because you have the guarantee and using the guarantee the BNG and NWB will give you funds immediately and other banks too.
>
> — Finance expert, sector organisation, The Netherlands

In the Netherlands, it is a common practice by rating agencies to rate SHO's debt top-down, that is starting from the rate of the guarantor, ultimately the Dutch state, currently rated AAA. Similarly, an interviewee from a French public bank highlighted how interest is not determined based on the credit risk of the borrower, but on the energy efficiency and rent ambition of the project. In France and the Netherlands, state-backed operators are shielded from transitional risks. Despite this state

guarantee, some of the interviewees raised concerns about guarantee coverage for SHOs with non-energy-efficiency assets in the future (see Figure 3 for cross-country details).

One of the interviewed consultants highlighted that, over the long run, the possibility of stranded assets due to chronic shortcomings in renovation poses risks for further deterioration of leverage ratios. Although this is unlikely to jeopardise access to capital for the sector, it may put increased pressure on individual organisations which are already reducing development activities and in some cases increasing rents. The ESG focus on environmental criteria, together with MEPS, pose the risk of stranding assets and are steering SHOs toward renovation investments. As a result, unless there is substantial non-market financing, SHOs are reducing their development pipelines and increasing rents where possible.

How are national management practices and organisation characteristics interacting with "greening" capital markets?

As presented in section two, the use of sustainability indicators, as introduced by the EU's Sustainable Finance Framework, has the objective of identifying management activities and companies delivering on ESG priorities and steering capital markets towards them. However, our findings show that particular management practices and institutions make certain SHOs and countries more suitable for ESG finance. On the one hand, SHOs in the Netherlands raise finance on a portfolio basis, that is finance their operations in bulk. In the other studied countries, SHOs tend to raise capital for specific projects. The EU's legislation "greening" capital markets introduces granular disclosure at project level which poses administrative difficulties for Dutch SHOs and their funders:

> We have what they call a balance financing [...] and that makes it hard to report on an individual loan. (...) Our data, the impact reporting, is done by the umbrella organisation of the social housing organisations, AEDES.
>
> — Finance expert, promotional bank, The Netherlands

While reporting at project level clashes with the financing of Dutch providers, it is particularly suited to the French system where the loan interest is set depending on the future occupants' income and hence defined at the project level. These pre-existent particularities are having a direct impact in the adoption of the EU sustainable finance legislation as well as in setting market benchmarks:

> Among the institutional investors, so all central banks, insurance company, asset managers that are really dedicated to invest in ESG project. [French Public Bank] is really flagged as an exemplary issuer. And it's enabled us to in fact, accelerate the evolution of the market to accompany the transition also on the market side to encourage new issuers to enter in the market and to accelerate the building of new standards.
>
> — Finance expert, promotional bank, France

This particular promotional bank is in fact already incorporating taxonomy criteria in their lending as a market-shaping mechanism. Thanks to the interconnectedness between SHOs' balance sheets and the financial system, SHO debt has a great potential to strengthen the position of national private and public banks in the cases where the right data and procedures can be easily used to relabel it as green. In Denmark, where there is a tightly regulated credit market linking project, mortgage and bond, the greening of debt opens up further price differentiation opportunities:

> We're also trying now to make some kind of a green labelling because many of these bonds, they are attached to buildings with a high energy efficiency. And we have all kind of registration and retaining system. We know who lives in our buildings, know how old they are and we know everything about them.[. . .] So just like that we can make a connexion between the energy efficiency of the building and the bond.
>
> — CEO, large SHO, Denmark

The intertwining of state and SHOs is also producing positive effects for the Austrian financial sector. The introduction of high energy efficiency requirements to access public funds strengthens the position of these debt holders by reducing the financial operator's risks and their associated capital requirements:

> So as soon as we get the money of the state [. . .], it's a proof that every regulation is really uphold and stated and for that reason the bank doesn't ask anymore detailed questions to our company.
>
> — CEO, large SHO, Austria

> So all Austrian non-profit housing associations have very strict criteria to fulfil regarding the new building. So if they want the state funding they have to fulfil these criteria which are really like the Taxonomy criteria now. For them, it's really no problem to fulfill them, and just one sentence regarding the funding from state or public entities is enough.
>
> — Lending officer, bank, Austria

These quotes show that, in Austria, state-led subsidisation and standard-setting is already steering housing production toward environmental goals, while in France, size is a key determinant of access to the bond market since bond issuance below €200M is not profitable due to administrative costs. Financial intermediaries, such as the Caisse des Dépôts, are key in ensuring access to capital for SHOs of smaller size that would otherwise be completely dependent on bank lending. Size and/or government support through bond aggregation are key in providing financing to smaller organisations. In Germany, a critical example of a frontrunner relying on size is Vonovia, the largest for-profit SHO in Europe which released one of the first taxonomy-aligned green bonds reaching a 10 bps premium (Vonovia, 2023). These large differences between providers highlight how ESG on its own without the right intermediaries or state intervention is poised to benefit a minority of large providers such as Vonovia or Clarion (see Introduction. Size and stock quality seem to be the

key determinants for providers to access ESG capital. While for-profit providers, which are focusing on new-build affordable housing stock, are issuing green bonds; those SHOs with a less energy-efficient stock and smaller business volume seem to be falling behind:

> We tried to prepare green bonds for housing associations, but they are not gonna meet the requirements because if you look to their housing stock, that's what we call legacy housing stock. So that's an aging housing stock with overall quite poor EPC ratings. And nowadays they say well, we are on an average of EPC-C, yeah, but C, I mean thumbs up, but that's half your way. You can have a very complicated story about green bonds, but there is one simple reason. Housing associations, which have an ageing housing stock, simply cannot comply with the green bond principles [Taxonomy] and for instance, if you are in the UK, if you are a for-profit registered provider [SHO] of affordable housing and you have been able to build your portfolio from scratch, (….) you are already pretty close on meeting your green bond standard — Finance expert, consultancy, Europe

Ultimately, ESG finance is yet to accomplish its redistributive objectives and is impinging on prior divisions across providers and countries. The introduction of further disclosure criteria would affect portfolio financing countries such as the Netherlands, by requiring disclosure at project level, while current sustainability bonds usually build on sector or company averages. These phenomena point to ESG being part of a cream-skimming logic guiding investors to safe projects with strong public backing or large commercially oriented companies. Size and stock quality are determinant in accessing capital markets and it is profit-geared SHOs that are poised to benefit the most since they can produce economies of scale and in some cases have larger proportions of new-build in their portfolio.

6.5 Discussion

ESG legislation has triggered a series of forces that are reconfiguring social housing financing systems. Despite strong differences across national financing frameworks, this paper has identified three major homogenising forces: 1) reporting obligations, 2) renovation requirements and 3) "greening" of capital markets (see Table 3). Within these homogenising forces, this study's findings for five EU countries evidence contradictory outcomes produced by the reorganisation of SHO financing along ESG lines. First, ESG legislation is expanding reporting responsibilities while producing only limited additional finance ultimately reducing interest rates (Contradiction 1). According to the interviewees, ESG reporting is not always conducive to a lower cost of capital. Guarantees, revolving funds and strong equity are some of the factors preventing the materialisation of a lower interest rate that are explored at the country level below. Second,the expansion of energy efficiency requirements increases

capital expenditures creating tensions with SHOs' social mission of providing new affordable homes (Contradiction 2). ESG together with legislation on energy efficiency accentuates the importance of housing decarbonisation as both a financial risk and a new standard. This has a direct impact on SHOs' financing since their capacity to recoup investment is usually limited by rent caps. Notwithstanding wide differences across providers and countries, renovation requirements produce tensions with SHOs' social mission as the differences impinge on the SHO's capacity to maintain lower rents and build more homes. Third, instead of producing widespread easier access to debt, the reconfiguration of capital markets along ESG criteria favours particular social housing provision systems, with either strong government support or larger commercial providers (Contradiction 3). This comes about because ESG legislation intends to clearly label funds and bonds to increase transparency in the allocation of capital to aligned projects. However, practices such as portfolio financing and factors such as company size and data availability condition SHOs' capacity to access "green" investments. This results in an uneven playing field where larger, more commercially oriented SHOs in particular countries are better suited to "green" investments.

The three contractions therefore show that the common intended trajectories do not materialise equally across the different social housing financing systems. Following Aalbers (2017), the tensions between homogenising and heterogenesing forces result in variegation across national social housing financing systems (see Table 4). The first contradiction mainly results from the existence of strong guarantees and public intermediaries which reduce the margin on which ESG reporting can produce further price differentiation. Countries with these features rely heavily on public promotional banks, as in The Netherlands and France and to a certain extent Denmark and Austria where state backing takes the form of sizeable grants and bond-purchases (see also Figure 3). In these cases, greening social housing financing produces, for now, low green premiums. Quantitative evidence on sovereign debt issuance backs these views, as the econometric analysis by Doronzo et al. (2021) also found little evidence of premiums being related to ESG public debt issuance. In contrast with the lack of interest rate incentives in Germany, which tends to have more commercially geared SHOs, the adoption of ESG debt instruments is driven more directly by reductions in the cost of debt. In summary, the introduction of homogenising ESG reporting standards is having a differentiated impact producing divisions across social housing financing systems. Ultimately, interest rate rebates are not perceived as the main driving force toward green debt for a majority of the interviewees but more as a cultural shift toward the engraining of environmental indicators in lending. While ESG certifications broaden the investor base and make SHOs more "legible" to investors, it is only in those systems that are more dependent on private finance that ESG disclosures produce higher green premiums.

TABLE 6.3 Overview forces effects and contradictions

No.	Intended Effect	Actual Effect	Contradiction
1) Reporting and Disclosure Obligations	To lower the cost of capital for ESG-aligned activities	Impact on interest rates limited to commercially oriented SHOs. Increase in administrative costs.	Between ESG and (some) national frameworks already in place to support social housing provision
2) Renovation Requirements and Energy Performance Standards	To sustainably increase renovation rates and overall energy efficiency while avoiding negative social impacts	Focus on renovation steered to reductions in newbuild, rent rises, and disposals, in some instances.	Between ESG and the sector's social objectives: lower rents and new housing provision
3) "Greening" of Capital Markets	To redistribute finance toward those sectors and activities where it can produce a high impact	Entrenchment of inequalities in access to finance. Certain management practices are not easily amenable to ESG. SHOs' size and stock strongly impact SHO capacity to tap onto green markets.	Between Green Capital and organisational characteristics and management practices

The second contradiction of higher finance costs jeopardising SHOs' social mission is a consequence of renovation requirements, a homogenising force (see Table 4). Renovation requirements affect the capital expenditures of organisations differently depending on whether these rely on grant or debt funding. Grants result in lower leverage ratios, which strengthen the risk profile of SHOs in the eyes of rating agencies, for example, in Austria (see also Figure 3). In 'guarantee' countries, where SHOs have strong linkages to the sovereign, rating is done top-down, which shields them from environmental risks, de-risking their borrowing. This phenomenon offers similarities with the de-risking of for-profit real estate portfolios through state intervention analysed by Aalbers et al. (2023). However, in the case of limited profit SHOs, leveraging limits are constraining those in more financially fragile situations, despite the state backing. Guarantee providers, key actors in state backing, are still discussing how to incorporate environmental and transitional risks in the analysis of SHOs to mitigate the impact it may carry on their access to debt. In response to renovation requirements impinging on costs and increasing borrowing, most of the interviewed SHOs are reducing their new-build pipelines, passing on costs to residents where the rent-setting system allows it and also considering disposing of their less energy-efficient stock. On a similar note to that of Knuth (2016), the emphasis on environmental indicators disregards the social objectives of SHOs activities. Austria and Denmark operate more independently from financial markets because of the provision for renovation having been included in rent-setting and the existence of revolving funds (see Figure 3). As also highlighted by the literature (Kössl, 2022), cost-based rent setting is one of the key features which allows the renovation and new social production in Austria together with high levels of government grant.

TABLE 6.4 Contradictions, Heterogenising and Homogenising Forces

Contradictions	*France*	*Netherlands*	*Germany*	*Austria*	*Denmark*	Forces
1st	**Reporting and Disclosure Obligations**					
	Limited Incentives	Limited Incentives	Large incentives for commercial operators	Limited incentives	Limited incentives	Hom.
	Strong Guarantees and Counter-cyclical public lending	Strong guarantees and counter-cyclical public lending	Economies of scale in large operators	Strong public intervention through grants	Partial guarantee and strong legislation	Het.
2nd	**Renovation Requirements and Energy Performance Standards**					
	Relevant leverage limitations	Relevant leverage limitations	Relevant leverage limitations			Hom.
	Low financial risks due to guarantees	Low financial risks due to guarantees	Temporally limited rent caps reduce financial risks	Cost-based rents reduce split incentives and strong grants reduce leveraging and risks	Revolving funds at country level and provision for renovation in rent setting reduce risks	Het.
3rd	**"Greening" of Capital Markets**					Hom.
	Public lending embedding ESG criteria in lending provision	Clashes with portfolio finance	High variation in adoption across providers	Public intervention aligned with financial markets	Public intervention being aligned with financial markets	Het.

The third contradiction results from the uneven impact greening capital markets are having over providers in the studied countries. Both decarbonisation and ESG debt issuance reward economies of scale, underlining the role of aggregators and banks. As reporting of use of proceeds becomes more detailed, 'project' finance countries have an advantage over 'portfolio/balance' ones. However, SHOs are not only passive actors in financial systems, and the incorporation of transitional risk indicators into banking is producing positive effects in some countries. For example, in Austria, the good quality of the housing stock together with its self-financing mechanism is strengthening the perceived position of private banks. ESG issuance seems to be embedded in a process of cream-skimming rather than on the spreading of investment where it can produce a higher impact.

To sum up, the identified contradictions between ESG and decarbonisation trace the limitations of market-based green financing of social housing. The interplay between national social housing financing systems and the homogenising force of ESG finance results in a range of outcomes. On the one hand, in Austria and Denmark, with relatively more countercyclical reliance on self- and public-financing mechanisms, SHOs are relatively independent of ESG finance. In France and the Netherlands, public support by banks and guarantees is protecting SHOs in their transition efforts towards ESG finance. Finally, when it comes to the German more commercialised operators with only occasional links to the state, ESG finance impacts on social housing financing are larger in terms of heterogeneity across SHOs and cyclicality.

6.6 Conclusion

This paper has focused on the multi-faceted interlock between ESG finance and the decarbonisation of the social housing stock. The results show that ESG legislation is expanding reporting responsibilities while producing only limited additional finance ultimately geared towards large and commercially oriented SHOs and debt aggregator organisations. Furthermore, the expansion of MEPS in countries like France and the Netherlands is already resulting in higher costs creating tensions with SHOs' social mission of building homes at affordable rents. Finally, the adoption of ESG financing is producing inequalities in access to capital across national financing systems and individual providers.

These results signal that the greening of SHO debt together with the incorporation of transitional and environmental risks is affecting the financial systems' configuration and opening up a number of questions and scenarios requiring further research. First, the accrual of green premiums could be taking place at the fund and investor levels and not yet having materialised into interest rebates for SHOs. Second, the ECB's 'tilting' toward green securities may reinforce green premiums in the secondary market as inflation recedes and Quantitative Easing (QE) is re-established.

Ultimately, the three contradictions identified in this study are not posited as definitive flaws in green finance, but could well be the result of adjustment pressures instead of the establishment of systemic tensions. Fully evaluating the impact of ESG indicators on social housing financing will require more research in the longer run, also drawing from quantitative evidence. Moreover, ESG-related acts and directives are just one set of policies in a broader regulatory landscape that includes multiple tools and renovation models for example Energy Service Companies (ESCOs) and One-Stop-Shops (OSS). Also, the future expansion of the Emissions Trading Scheme (ETS) to buildings and transport may increase the financial viability of housing renovation. Fertile ground for future research lies at the intersections of these stimuli that combine financial incentives with institutional design.

Our research highlights how debt aggregators have become a relevant response to increasingly complex capital markets requiring large debt issuances. These institutions provide both access to financial markets and data management and reporting expertise producing economies of scale and improving access to finance for smaller SHOs. When it comes to mid-term policy recommendations, the development of aggregators through regional public banks could further access to ESG capital for a wider array of SHOs. Furthermore, one of the most immediate changes of ESG legislation that could improve SHO access to private capital could be the introduction of housing affordability as a Principal Adverse Indicator (PAI) extending the 'do no harm' principle of ESG in a social dimension.. Finally, over the longer run, there is a need to advance the 'S' in ESG to showcase SHOs' work in financial markets. The Social Taxonomy but also the labelling of debt emitters as ESG-only could reduce administrative burdens and further the access to sustainability-labelled debt.

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7 When Land is not Enough

drawing in private investment to increase social rental housing in Spain

Abstract [1]

Since the 1990s, many governments have reduced direct funding for social housing. In Northwestern Europe, indirect subsidies and guarantees have allowed private providers to maintain and expand the social rental stock. In contrast, Spain's social rental sector has remained underdeveloped. Amid the current affordability crisis, attention to social housing is growing, emphasized by a new law prohibiting the sale of public land zoned for this purpose. Given public expenditure constraints, Public-Private Partnerships (PPPs) have emerged as an alternative to finance new construction. These partnerships involve leasing public land at reduced costs to private entities for social housing development. Despite land availability, financial challenges persist and tenders often fail to attract private sector interest. This paper examines constraints affecting social housing development by exploring a PPP by the Catalan Land Institute. The central research question is: How do institutional dynamics and financial constraints impact the provision of social rental housing in Spain? To answer this question, a mixed-methods approach integrates interviews with a sensitivity analysis of key parameters in a discounted cash flow (DCF) model. The findings underscore high financing costs, weak renter protections, and misaligned fiscal policies as significant obstacles. The paper recommends further investigating public-backed guarantors, housing allowances, and fiscal incentives to address these challenges.

7.1 Introduction

Across Northwestern Europe, private and third-sector partners play central roles in maintaining and expanding social housing stocks. Since the 1990s, countries like the Netherlands and the United Kingdom have reduced their government's direct involvement in housing provision, opting for market mechanisms to sustain and develop the social housing stock (Elsinga et al., 2016; Whitehead, 1999). As a result, in England and the Netherlands, the proportion of the social housing stock provided by limited profit companies has risen to 62% and 79% respectively (OECD, 2022). To align housing supply below market rates with the financial viability of private operators, Northwestern European countries have adopted a variety of support measures, including grants, state guarantees, land designations, and subsidised loans (Whitehead, 2014). This has come not without critique as reliance on market mechanisms has brought Private-Public Partnerships (PPPs) under criticism due to a focus on profit over social purpose (Aalbers et al., 2017) (Wainwright & Manville,

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2017).

A growing body of scholarly literature has examined the effects of various policy instruments on the financial viability of affordable rental housing. These can be broadly classified under supply-side, fiscal, social and planning policy instruments, see for example Lawson et al. (2010), Norris and Lawson (2022) or Peverini (2023). Recently, in the UK, overlapping policies have been conceptualised as a form of polycentric regulation, requiring social housing corporations to comply with both direct regulatory bodies and financial requirements (Raco et al., 2023). Along these lines, recent research has highlighted the varying impact that sustainable finance regulations have on social housing providers across Europe, primarily due to their dependence on private investment (Fernández et al., 2023). This paper expands this body of literature by analysing the policies affecting social housing PPPs in Spain. Here, the term social housing is used to refer to Viviendas de Proteccion Oficial (VPO) or Habitatges de Protecció Oficial (HPO) in Catalan which target households with incomes below certain thresholds[2].

Historically, homeownership was the main tenure of VPOs, ultimately enabling vast swathes of the Spanish population to access homeownership but neglecting the creation of a social rental housing stock (Pareja Eastaway & Varo, 2002). This historical weakness of the Spanish model calls for a broader approach to analysing social rental housing finance. In response, this article takes a comprehensive view of the financial, social, and fiscal policies impacting social housing provision in Spain. In doing so, it draws from a case study of a land-lease Public-Private Partnership (PPP) initiative by the Catalan Land Institute (INCASOL) to explore the question: How do institutional dynamics and financial constraints influence the provision of social rental housing in Spain? The main body of evidence comprises semi-structured interviews with public officials, private developers, and financiers. This qualitative approach is complemented by a Discounted Cash Flow (DCF) analysis, commonly used to assess financial viability in housing development. The DCF model illustrates the impact of key parameters such as interest rates, arrears, and taxes on financial viability.

Ultimately, this article makes a two-fold contribution to the literature on social rental housing. First, it enhances the understanding of the historical development of the Spanish social rental housing system, highlighting the institutional arrangements and financial mechanisms at play, as well as their shortcomings. It does so through a dialogue between both the experiences of key decision-makers and the financial

[2] Granath Hansson and Lundgren (2019), identify household targeting as the most consistent criterion across various definitions of social housing. In the Spanish context, the legislation uses the term Vivienda de Protección Oficial (VPO) to refer to dwellings provided for households below a certain income threshold, regardless of tenure. This article adopts the income threshold criterion to define social housing but focuses specifically on social rental housing, which requires distinct management and financing approaches compared to homeownership. The term "affordable housing" is used as shorthand in the literature review and discussion sections to describe similar housing tenures in countries other than Spain. For example, in the U.S., affordable housing often refers to units developed through Low-Income Housing Tax Credits (LIHTC), while state-owned housing is referred to as public housing (Schwartz, 2021). In the UK, the National Planning Policy Framework (MHCLG, 2023) defines affordable housing as an umbrella term covering both rental and ownership units, similar to the Spanish case. Within rental housing, different formulas are used to set "social rents" and "affordable rents". Notably, in the UK, the terms "social housing" and "social rents" do not refer exclusively to publicly owned housing; both social and affordable rent units are provided by third-party and publicly owned operators (MHCLG, 2023).

specifications of a particular project. A key element of the contribution resides in the mixed methods approach that provides insight into investors' rationale. Second, the paper situates a Southern European case study within the social rental housing finance literature, a field traditionally focused on Northwestern Europe. By doing so, it engages with recent empirical literature emphasizing the importance of financial regulations and social policy on housing development and maintenance.

The next section reviews the academic literature on policies to strengthen social housing supply, followed by the methodology and analytical framework. The following one introduces the Spanish context and justifies the main methodological choices. Then, a historical overview of social housing in Spain highlights key legislation and their socioeconomic context. The fifth section analyses qualitative and quantitative evidence from the case study. The final sections discuss the findings in relation to the literature and conclude.

7.2 Debates on Social Housing Provision through PPPs

The rationale for PPPs leading to the growth in the private-led provision of social services throughout the 1990s and early 00s (Kappeler and Nemoz, 2010) was the modernisation of public services by incorporating market-led operators that would increase efficiency allowing for the thinning of state bureaucracies (Savas, 2000). The involvement of private finance has usually been led by constraints in public capital and public administrations' reduced capacity to operate and manage services (Akintoye, 2016). For example, in the paradigmatic case of the English social housing stock, large transfers were realised as a response to the need for investment to raise home standards (Barker, 2004) (Hodkinson, 2011). In Spain, the analysis of PPPs from a financial efficiency perspective offers a mixed picture. For instance, in 2015, the National Markets and Competition Authority (2015) highlighted that private sector partners overprice services by 25% on average when hired by public administrations. While this study refers to the general contracting of services by the administration and not only housing, Ramió Matas (2016) highlights this as part of a broader trend in Spain resulting in privatised benefits and socialised costs.

When it comes to PPPs, land policies, reserving a proportion of this resource for social housing provision, are a relevant tool to improve the financial viability of affordable housing supply in many contexts (Lawson et al., 2022). For example, in England, developer contributions under S106 are instrumental in securing a relevant proportion of social housing in new developments (Whitehead, 2007). In Vienna, a public land bank coupled with direct subsidies, conditional on cost-based renting,

have a dampening effect on land prices thus increasing the financial viability of social housing development (Lawson & Ruonavaara, 2020). Overall, access to land eases the financial requirements of housing provision by eliminating or reducing one of the main costs. However, as the current case depicts, land policy may not completely solve viability concerns in the development and exploitation phases.

Together with land reserves, the academic literature has also focused on an array of financial policies geared towards increasing social housing supply. First, social housing systems may be underpinned by reduced borrowing costs facilitated through public backing. In a number of European countries, in the 1990s, social housing provision was opened to private investment. In the UK, this took place through large stock transfers to third-sector social housing organisations (SHOs) that received public grants to de-risk private investment (Whitehead, 1999). Other countries chose to follow a different path, for example, the Netherlands implemented a state guarantee to reduce the risk premium on SHOs' debt (Elsinga & Wassenberg, 2014). In contrast, France and Germany provide a series of subsidised loans for new social housing developments (Lévy-Vroelant et al., 2014) (Droste & Knorr-Siedow, 2014). This opening of social housing to private investment has elicited critiques for an excessive focus on financial performance. For example, Wainwright and Manville (2017) see the incorporation of bond financing among English SHOs as driving an excessive focus on financial metrics at the expense of social objectives.

Second, social housing supply has traditionally relied on a favourable tax treatment, or outright exemptions, to increase the financial viability of projects delivered by private and third-sector companies. For example, in Germany, tax relief in the form of a depreciation allowance was increased in 2019 to foster the development of affordable housing (Lerbs & Nobbe, 2021). The Low-Income Housing Tax Credit (LIHTC), in the US, is probably the best-known among these programmes. LIHTCs subsidise the development and rehabilitation of affordable housing through corporate tax reductions awarded by the Federal Government (Schwartz, 2021). Currently, most affordable homes in the US are delivered through this system of tax exemptions (Schwartz, 2021). In the last decades, the OECD has identified an increase in tax exemptions for affordable housing provision which have become a widespread tool for social housing financing in countries like Chile, France, Portugal and Colombia (OECD, 2022). This shift has been characterised both as a step towards the development of intermediate tenures but also as a commercialisation pressure (Wijburg, 2022).

Thirdly, demand-side subsidies in the form of direct housing allowances to households have become a key feature of the social safety net in many countries as brick-and-mortar subsidies for social housing development were rolled back (Kemp, 2012). The popularity of housing allowances is linked to the US Experimental Housing Allowance Program. This program investigated housing consumption responses resulting from direct cash transfers to low-income households. Evidence from this experiment pointed to housing allowances inducing households to live in better-quality housing (Mulford et al., 1980). While housing allowances are usually presented as an alternative to direct social housing provision, in practice, allowances also reduce arrears in the social sector (see also Kemp, 2007; Turner & Elsinga,

2005). This is the case particularly after the social housing stock started to be operated by third-party actors. For example, in the UK, housing allowances make up a sizeable proportion of SHOs' finances and, by assuring revenue from vulnerable residents, are inextricably linked to development strategies (Stephens, 2005; Wilson & Barton, 2017).

As the literature shows, the long-term financial viability of social housing developments hinges on the definition of a financing framework usually achieved through a mix of social, financial and planning policy instruments. These changes in social housing provision, from fully state-led to the introduction of other actors, have resulted in complex governance frameworks. As a result, access to capital markets has improved and the voluntary sector has been professionalised arguably at the expense of tenant participation (Gibb, 2002) (Lunde & Whitehead, 2016). These developments also speak to a broader shift towards decentralised and multi-level governance across different levels of government and networks of public and private actors. Kersbergen and Waarden (2004) highlight how these arrangements are generating interdisciplinary research areas for social science. When it comes to social housing, Raco et al. (2023) propose the term polycentric regulation to address the multiple forces that push and pull English SHOs in the definition of their social and financial strategies. Peverini (2021) also postulates a similar framework to address the role of urban governance on housing affordability. Furthermore, the increasing impact of multiple layers of legislation on social housing provision is also highlighted in Fernández et al. (2023). This paper employs a comparative approach to explore how national social housing financing frameworks adapt to the EU legislation on green finance.

These studies underscore the impact multiple legislative poles have on the provision of social housing. This paper hones in on three specific dimensions within the Spanish context: supply measures, fiscal policy, and demand-side subsidies (Table 1). In practice, these instruments often become more nuanced post-implementation, for instance, in the US, the sale of LIHTC to financial operators results in this policy behaving akin to an up-front grant rather than a recurring fiscal benefit (Schwartz, 2021). Consequently, the classification of policies presented in Table 1 is employed as a heuristic instrument to structure evidence, rather than a rigid taxonomy of policy instruments. The subsequent empirical sub-questions ask: 1) How have legislative and socioeconomic developments shaped PPPs for social housing provision within the Spanish and Catalan contexts? 2) How do financial constraints, when considered in conjunction with fiscal and social policies, currently impact the viability of PPPs for social housing provision? These questions, answered in sections four and five respectively, ultimately align with the objectives of presenting a comprehensive overview of the current social housing financing structures in Catalonia and assessing the policies impinging on the financial viability of supply.

TABLE 7.1 Social housing financing policies

Policy	Supply-side subsidies	Fiscal Policy	Demand-side subsidies	Planning Law
Target	Housing Unit	Housing Unit	Household	Land
Examples	Grants – UK; Subsidised loans – FR	LIHTC – US	Housing Allowances – UK	Land reserves – AUT

Source: Prepared by the authors

7.3 Context and Methodology: a Mixed-Methods Case Study

Despite a long-standing policy focus on homeownership, stepping onto the housing ladder has become out of reach for many. In 2023, the average household needed 36% of its income to access a mortgage, 6% more than in 2020 (Observatorio de Vivienda y Suelo, 2023). Rising housing costs disproportionately affect lower-income households, with 47% of private renters and 28% of homeowners in the lowest income quintile spending over 40% of their income on housing (OECD, 2022). While this rate is much lower in the social rented sector, 12%, years of underinvestment from public authorities, coupled with policies centred around homeownership, have dwindled the proportion of socially rented housing stock to about 2.5% (Observatorio de Vivienda y Suelo, 2022).

In 2023, in response to the affordability crisis, the Spanish Parliament enacted a new Law on the Right to Housing (12/2023), a pivotal piece of legislation introducing the option of rent controls in the private rental sector and also aimed to promote new social rental housing. Since the short-lived introduction of rent controls in Catalonia between 2020 and 2022, this policy has become a topic of fervent public debate eliciting diverse perspectives from economists (Kholodilin et al., 2022; Monras & Montalvo, 2023) (Jofre-Monseny et al., 2023) and legal experts alike (Simon, 2023). Conversely, the development of the social housing stock has remained relatively unattended in academic research despite some relevant contributions (Gifreu i Font, 2023; Burgués & de Molina, 2019).

To increase the social stock, the Law on the Right to Housing (12/2023) together with previous regional housing laws (Gifreu i Font, 2023), placed specific emphasis on fostering PPPs through land leases. Under this model, publicly owned land is leased to a private partner for the construction and management of social housing.

So far, this approach has yielded mixed outcomes. Subnational governments, such as the Metropolitan Government of Barcelona [3] and the Region of Madrid (Orden 951/2021, Orden 1270/2021), have, only at times, successfully engaged private partners to execute part of their housing initiatives. On other occasions, these same institutions together with the Generalitat Valenciana have failed to secure any private developers' bid for their social housing plans[4].

This paper approaches the questions presented above through a case study of INCASOL's land-lease PPPs. As the land management authority in Catalonia, INCASOL both directly provides housing and organises land development. Recently, INCASOL has released three plots zoned for social rental housing in an open bid to be developed and managed by a third-party organisation. Reliance on a private partner operating in a financially constrained manner makes this a particularly compelling case to investigate social housing delivery. To do so, this paper develops a mixed methods approach, following a design that starts with qualitative input and is then expanded through quantitative modelling. In the first phase, 21 in-depth interviews with professionals served both to understand the institutional context together with the motivations of public and private stakeholders. In the second phase, the encoded responses informed the selection of particular parameters for further exploration through a sensitivity analysis in a Discounted-Cash-Flow (DCF) model assessing the developments' viability. The objective is to demonstrate the broader relevance of the concerns raised by the interviewees and illustrate their financial viability implications through a sensitivity analysis of key parameters. This approach aligns with the logic of a primarily qualitative method, supplemented by quantitative elements (Morgan, 2014).

While the nucleus of the research focuses on INCASOL and Catalonia, the set of interviewees encompasses other Spanish regions to make any broader extrapolation of results more robust. Participant selection included an array of actors involved in the formulation, financing and oversight of land PPPs. That is, first, public partners leasing land; second, private developers and managers of social housing and; third, private and public financial institutions financing these projects (see Table 2 for detail). The actors selected are similar to those interviewed in the study of social housing financing in other contexts, see for example, Raco et al. (2023) and Fernández et al. (2023). Recruitment took place through professional networks attending to criteria of prior experience, decision-making capacity and technical expertise. Interviews were conducted both in person and online throughout 2023. The semi-structured interview protocols[5] were designed to delve into three topics 1) the rationale for land-lease PPPs, 2) the minimum requirements for investment, and 3) the long-term implications of this form of housing provision. Subsequently, the answers were coded in Atlas.ti attending to the incidence of specific narratives regarding borrowing costs, fiscality and social policy (Appendix A).

[3] https://ajuntament.barcelona.cat/lescorts/es/noticia/nace-el-primer-operador-de-vivienda-publicoprivat-del-estado_1117294.

[4] https://www.elconfidencial.com/empresas/2021-12-02/generalitat-vivienda-alquiler-plan-estrella_3334537/.

[5] Consent was sought in written form for all interviewees. A public disclosure provision was included in the consent form when referring to employees at INCASOL where ensuring anonymity was impossible.

TABLE 7.2 Interviewee Groups

Actor	Count
Private partner: (not) for-profit SHO	5
Case study: INCASOL	6
Other public partners: regional and local governments	5
Financing Institutions: public and private banks, rating agencies	5
Total	**21**

Secondly, building on the interview responses, a sensitivity analysis of key parameters in a Discounted Cash-Flow (DCF) is used to quantitatively illustrate financial viability issues. This responds to a call by Poovey (2015) for engagement with financial decision-making tools in housing research. This paper quantitatively presents policy impacts on the financial assessments conducted to determine the viability of a specific social housing project. DCF models constitute a widely employed tool among real estate investors and public authorities for assessing rental housing appraisals and valuations (Ling & Archer, 2021). This valuation model relies on predicting cash flows and future value and then discounting them to appraise a current investment opportunity (Ling & Archer, 2021).

The Internal Rate of Return (IRR) is a key concept in financial analysis, particularly in the evaluation of investment returns. According to Ling and Archer (2021), the IRR is the discount rate at which the Net Present Value (NPV) of a project's cash flows equals zero. In other words, it is the rate of return at which the present value of the project's cash inflows matches the present value of its outflows. See the formula below, where: Ct = net cash inflow during the period t; C0 = total initial investment costs; IRR = the internal rate of return; and t = the number of time periods.

$$0 = NPV = \sum_{t=1}^{n} \frac{C_t}{(1+IRR)^t} - C_0$$

(1)

The IRR summarises the return of an investment opportunity. In investment decisions, if the IRR exceeds the project's required rate of return or cost of capital, the project is generally considered acceptable. Conversely, if the IRR is lower than the cost of capital, the project is not deemed viable. One of the limitations of DCF models is their highly deterministic nature drawing from a series of imputed parameters (see Appendix B for detail). In this case, the scrutiny of quantitative determinants is used to assess the interplay between affordability for the consumer and financial viability for the investor. Hence, the results presented acquire more relevance as the parameters modelled illustrate the concerns highlighted by the interviewees.

7.4 The Changing Role of Social Housing

According to 2021 data, Spain displays an imbalanced tenure breakdown with a high homeowner proportion, 75.2% of households (INE, 2023). Among the total households, 38.1% own their home outright and 26.4% have a mortgage. In contrast, only 15.9% of households are renters in the private market and just 2.8% are social renters (INE, 2023). Although the percentage of private renters grew by 2.4% between 2011 and 2021, (INE, 2023), reversing a historical trend in the increase of homeownership, Spain continues to rank firmly among the European nations with the highest percentages of homeowners (OECD, 2022). However, this was not always the case. In 1950, over half of Spanish households rented, but by 1995 this figure had dropped to 14% (Pareja Eastaway & Varo, 2002). Conversely, the proportion of owner-occupiers grew from 46% to 81% in the same period (Pareja Eastaway & Varo, 2002). The centrality of homeownership in Spain is the result of a series of policy decisions that privatised the public housing stock while subsidising mortgages, a process that started in the 1960s and fully unfolded in the 1990s.

Despite the historical emphasis on homeownership, the roots of the current PPPs and social housing system can be traced back to legislation prior to the new housing law. After the Civil War in 1939, the Dictatorship's first housing law (BOE-A-1939-6523) established the National Housing Institute to promote social housing, particularly through for-profit companies. This law provided tax exemptions and interest-free loans for properties built under specific rent thresholds. Subsequent legislation raised the maximum rents eligible for subsidisation to incorporate "middle classes" and stimulate economic growth through construction (BOE-A-1944-10964). Carbajal (2003) notes that, despite legislative efforts, the post-war focus on PPPs failed to meet objectives due to limited access to building materials, capital, and an inefficient subsidy system. Consequently, private development concentrated on mid-segment housing, while properties with the strictest rent ceilings were mainly developed by the National Housing Institute.

In the 1950s, two key features were introduced. On the one hand, the 1954 Law on the Construction of Limited Rent Housing (BOE-A-1954-10883) expanded the previous system of subsidies and fiscal exemptions. Also, from 1957 onwards, a newly created Ministry for Housing would become instrumental in the formulation and implementation of Housing Plans. A key element of these housing plans was the provision of social housing on a flexible tenure basis which eventually resulted in the privatisation of the social housing stock.[6] On the other hand, the 1956 Land Law (BOE-A-1956-135) established a system of development levies "cesion obligatoria" which required developers to cover public infrastructure costs in new developments. Furthermore, this law foresaw the possibility of transferring public land to private

[6] Article 26 of the 1954 law established that the housing units could be let for free, rented, sold outright or in instalments. The regulation that developed this law also determined that after 20 years, the dwelling would lose its "social" qualification. As a result, it would be free for trading in the open market and renters would become owners.

companies for the development of social housing.

Throughout the 1950s, the economic circumstances progressively changed compared to those of 1939. In 1953, the Pact of Madrid [7] ended Franco's regime international isolation opening access to development aid and international investment. In the 1960s, in the midst of unprecedented economic growth, public investment in social housing and for-profit private initiatives would lead to the development of vast swathes of urban peripheries into social housing. In fact, most of the Spanish housing stock was built during two boom periods during 1962 to 1967 and 1968 to 1974 (Taltavull, 2001). At this time, a number of private for-profit SHOs with a focus on social housing provision were created:

> Spain has traditionally had lax fiscal regimes for housing provision, particularly with total fiscal exemption for social housing provision. Our company was created [in 1968] under this fiscal regime. One of the advantages was not paying taxes and this would compensate for the limited rents. This was before there were any land reserves for social housing. — CEO, For Profit SHO

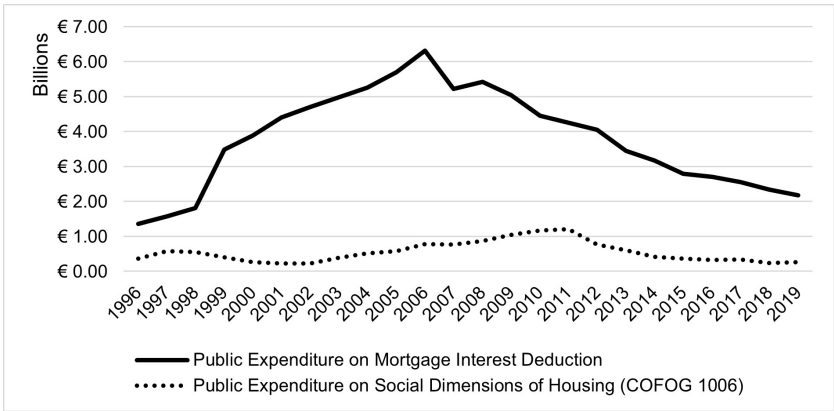
Public land reserves were only established in the 1975 Land Law (BOE-A-1975-9250), which built on the previous 1956 law and increased the developer contributions to public infrastructure and 10% of the value of the total development to local authorities. As a result, municipalities increased their land assets (Picazo-Ruiz, 2021). However, in many cases public institutions lacked the financial resources and administrative capacity to maintain or develop any social housing stock and land was sold back to developers. "Before [2020], the public administration could sell the land received as in-kind contributions by developers so far as the proceedings were reinvested in housing policy objectives". (Meritxell Jane Playa, Architect-Development Team, INCASOL).

In the 1980s, following the end of the dictatorship and the start of decentralisation, housing policy became the responsibility of regional authorities. Many regions established land institutes to manage land and housing assets transferred from the central government. After the dictatorship, housing policy continued to focus on homeownership as mortgage markets were liberalised and macroprudential policies were made more lax (Palomera, 2014). In Catalonia, the Law 4/1980 created INCASOL, which continued the low-cost homeownership policy throughout the next decades. As Fig. 2 shows, decentralisation did not result in structural changes in housing provision between Catalonia and Spain, particularly in recent decades, most social housing provision has taken the form of low-cost homeownership in both contexts. The flagship housing policy by public expenditure standards was Mortgage Interest Deduction (MID), which dwarfed the proportion spent on social housing provision (see Fig. 1). Even at the peak of social housing starts in 2008, public expenditure on social housing was markedly less than that on MID. Social housing provision remained centred on homeownership, contingent on land sales and

[7] The Pact of Madrid was a bilateral agreement signed in 1953 by General Franco, the dictator of Spain, and US President Eisenhower. The agreement allowed the US to use strategic military bases in Spain in exchange for economic aid to the Spanish regime. The pact marked the end of the international isolation that Franco's regime had faced since the end of WWII and contributed to its survival until 1978.

fluctuating following real estate cycles, as Fig. 2, and Fig. 3 show. Also, despite the existence of zoning laws and social housing companies, homeownership remained the preferred tenure in social housing developments, Fig. 3, Fig. 4.

FIG. 7.1 Public Expenditure on Mortgage Interest Deduction and Social Dimensions of Housing.



Sources: OECD, 2024 and Ministerio de Hacienda, 2021. Prepared by the authors.

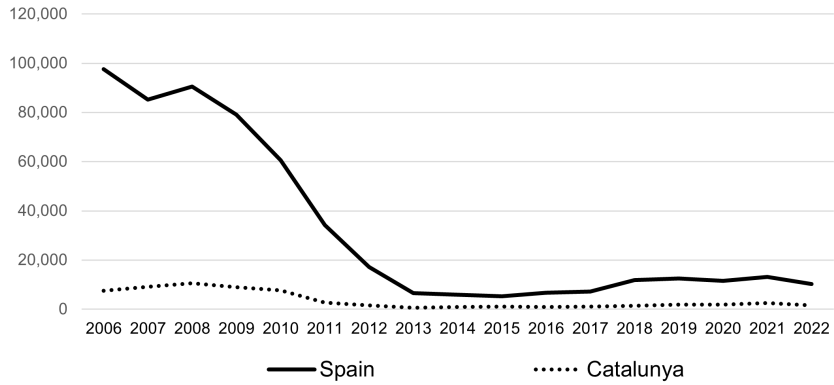
The 2008 crisis put an end to this era of social housing provision. In the midst of austerity and recession, the land market contracted and the Spanish administration lost one of its main revenue resources (see Fig. 2). Also, in the context of ballooning public debt, a cross-party coalition introduced legal limits to public expenditure through a budget stability law BOE-A-2012-5730. This law capped public deficit by all levels of government limiting countercyclical investments (Bellod, 2011). When it comes to housing, these debt ceilings still nowadays curtail the capacity of regional authorities to issue debt and directly fund housing provision.

> In this moment, for us to be able to build we would need to raise debt. This is particularly limited to the regional government. As a result, we won't be able to develop land directly because we do not have the financial resources. Thus, the only option for us to enlarge the public rental stock is through leveraging private investment. — Director of Asset Management, Regional Land Institute

In the aftermath of the 2008 crisis, alongside the retrenchment of public provision, a series of fiscal incentives were introduced to attract private investment from abroad through Real Estate Investment Trusts (REITs). In Spain, REITs owned by foreign investment funds are not only exempt from corporate tax but also from taxes on dividends paid to shareholders outside the country (BOE-A-2009-17000). Consequently, the number of REITs has grown exponentially while the administration broadly retreated from social housing development and management (Gil García & Martínez López, 2023) (Janoschka et al., 2020).

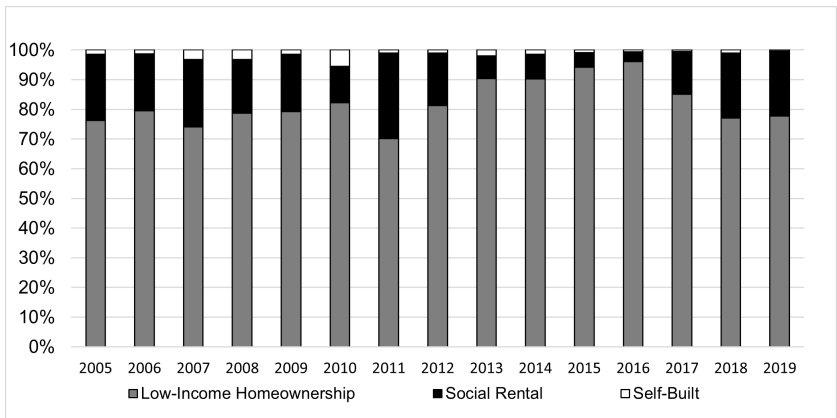
Together with these financial limitations, three legislative changes complete the

FIG. 7.2 Total Social Housing Starts.



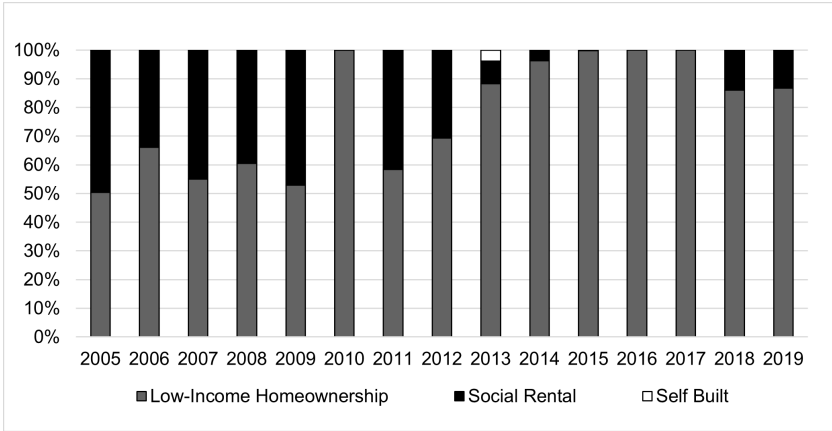
Source: Ministerio de Transportes, Movilidad y Agenda Urbana. (2024). Prepared by the authors.

FIG. 7.3 Total Social Housing Starts by Tenure in Spain.



Source: Ministerio de Transportes, Movilidad y Agenda Urbana. (2024). Prepared by the authors.

FIG. 7.4 Total Social Housing Starts by Tenure in Catalonia.



Source: Ministerio de Transportes, Movilidad y Agenda Urbana. (2024). Prepared by the authors.

current PPPs' framework. First, the 2007 Spanish Land Law (BOE-A-2007-10,701) expanded social housing reserves and mandated that a minimum of 10% of any new development be allocated to social housing. Second, the 2010 Catalan urbanism law improved over this minimum and raised the social housing proportion to 30% (Picazo-Ruiz, 2021). This change enabled local authorities or INCASOL, depending on the case, to secure a greater proportion of land value for social housing through development contributions. Third, in response to affordability challenges and the low provision of social housing (see Fig. 4), the Catalan Parliament passed the current Law on the Right to Housing in 2019 (BOE-A-2020-2509). This law aimed to increase the percentage of social housing in Catalonia from 2% to 5%. To improve housing affordability for tenants, the law introduced rent controls, which were later deemed unconstitutional and removed. However, it also prohibited the sale of public land zoned for social housing and increased the housing proportion reserved for social housing in developments to 50% in certain municipalities facing affordability pressures. Ultimately, the National Law on the Right to Housing (12/2023) incorporated both rent controls and the prohibition on selling public land into national legislation. As a result, public administrations across Spain are now required to maintain land zoned for social housing in public ownership and to develop a significant portion of it as rental housing. Land-lease PPPs have emerged as a response to financial constraints in achieving these social housing goals. These PPPs rely on public land zoned for social housing, which is developed by third parties and eventually returned to public ownership.

> First, land leases allow public institutions to maintain land as public property. This is an economic and fiscal reason as the asset ultimately returns to public stewardship after the end of the contract. Second, the public administration is reassured that the land will be used for its intended purpose, providing social

housing. Thirdly, over the longer run, the state aims to have an impact on market prices. — Lawyer, Legal Advisor to Public Partners in PPPs

In summary, the emergence of land-lease Public-Private Partnerships (PPPs) for social housing provision in Spain can be attributed to three core factors. First, there has been a longstanding reliance on private partners, including for-profit entities, to address the capital shortfalls in social housing provision. Second, the historical underinvestment in public infrastructure for the direct management and construction of social rental housing has been exacerbated by recent constraints on public expenditure following the Global Financial Crisis (GFC). Finally, recent legal reforms have restricted the alienation of public land designated for social housing development, thereby necessitating the involvement of private actors to mobilize capital and provide management expertise, as illustrated in Fig. 5.

FIG. 7.5 Actors, Processes, Concerns and Legislation in land-lease PPPs.

	Land obtained	Public Tender	Building Phase	Exploitation	Return to public partner
	• Affordable housing reserves • Public Property	• Criteria: rent setting, maintenance, duration	• 1 to 4 years	• 50,75 or 99 years	
Public Partner					
Private Partner					
LEGISLATION					
	• National & Regional Housing and Land Laws • Regional + Local Legislation Planning Legislation • Public Debt Ceiling	• Public Tender Law • Added Value Tax • Public Financing & Subsidies • Social Support Mechanism & Risk Premium	• Contract Terms • Corporate Tax • Building Standards		• Added Value Reversion Tax paid by private partner

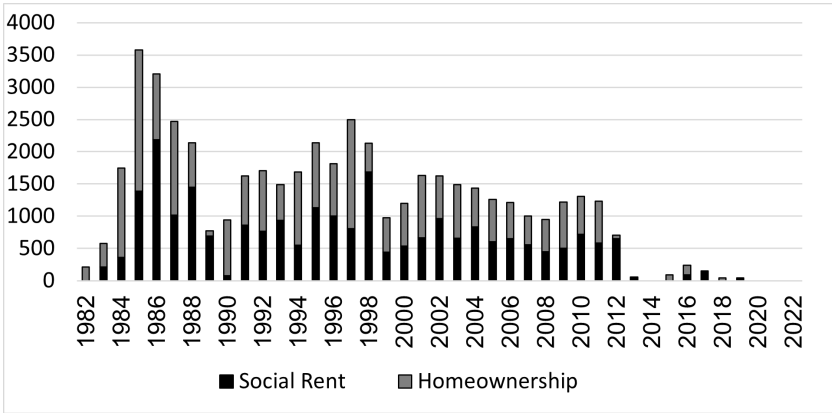
Note: In this case, land obtained through developer contributions is being tendered for lease to build affordable housing. The selection criteria for private partners in this particular tender include lowering rents below the threshold set in the legislation, returning the building to public ownership before the 75-year limit set, and exceeding minimum maintenance requirements. The winning bidder will gain the rights to develop and manage the social housing units on the released plots for the agreed term, after which both the land and building will revert to public stewardship. Source: Prepared by the Authors.

7.5 The Influence of Fiscal and Social Policies on PPP Viability

As a result of the aforementioned legal changes, INCASOL has also become unable to sell public land zoned for social housing. “Our social housing provision model relied on very strong capital gains resulting from land operations. This surplus was then invested in public social housing.” (Jordi Serrano-Codina, Finance Coordinator, INCASOL). Historically, INCASOL relied on land sales to finance housing development. This approach led to a sharp decline in housing provision following the 2008 crisis, mirroring the broader downturn in Spain and Catalonia (Fig. 6). According to the same interviewee, the reduction in land sales prompted INCASOL to tap into rental

deposits for housing development. Residential and commercial renters in Catalonia are required to place their deposits with INCASOL, providing the agency with a pool of capital at a 0% interest rate, as these deposits are returned at their nominal value.

FIG. 7.6 Social Housing Built by INCASOL.



Source: INCASOL. Prepared by the authors.

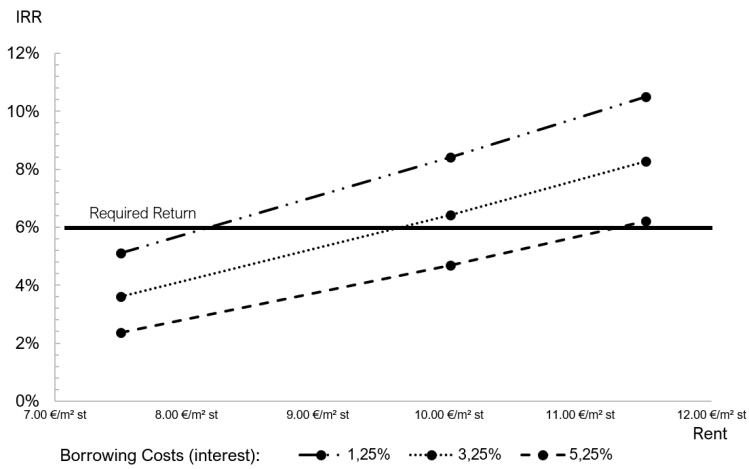
Despite INCASOL's relatively easy access to capital, the expansion of the housing stock to meet the regional housing plan targets is putting a serious strain on its finances and management capacity. "We can mobilise 90% of the deposits, but we are buttoning up against this limit" (Jordi Serrano-Codina, Finance Coordinator INCASOL), and also "project management and human resources constitute relevant bottlenecks for the development of social housing at scale" (Pere Picorelli, INCASOL). Land-lease PPPs have emerged as a response to develop land which otherwise would sit vacant due to limited public resources. In this case, the leased land is located in the Municipality of Esplugues de Llobregat, within the metropolitan area of Barcelona. Further details of the particular case are included in Appendix B (EXA 664/2023). Through a competitive process, INCASOL releases this plot that is to be built and administered by a third party and once the concession period is over will return to public management.

> The public tender defines three economic variables to competitively assess the tenders. The first one is social, lowering rents which benefits the residents. Second, returning the building to public management before the predefined period, which would benefit the administration. Finally, improving maintenance investments. — Pere Picorelli, Housing Programmes and Regeneration Coordinator, INCASOL

The private partner will need to incorporate these three elements in its financial assessment while keeping the project viable, that is deliver its required IRR — defined in the methodology section. In this regard, one of the key elements jeopardising viability is the balance between borrowing costs and rental affordability. The current

high interest rates hinder social housing development through traditional bank loans since rents are capped and are usually indexed to a more stable index than consumer prices or updated by regional governments on an ad hoc basis. As Fig. 7 shows, borrowing costs have a strong impact on the IRR. Borrowing costs reflect the risk of these operations but are also constrained by the pool of investors an SHO has access to. In Catalonia, public grants through the EU Next Generation funding stream subsidise two interest points in the loans offered by the Institut Catala de Finanzas (ICF).[8] While the funds available through this line of credit are limited, they are critical when it comes to not-for-profit providers' capacity to bid for these projects.

FIG. 7.7 Sensitivity Analysis of Capital Costs and Rent per sqm on IRR.



Source: INCASOL. Prepared by the authors.

> ICF has various lines of credit that subsidise social housing up to two full interest points. (. . .). As a consequence of the rising interest rates, development became very difficult. Before, we used to have private entities such as Triodos or Fiare. However, this is not viable anymore since EURIBOR is at 4% and the differential raises it to 5%. — Pere Picorelli, Housing Programmes and Regeneration Coordinator, INCASOL

Ultimately, project viability relies on grant funding which is available following European subsidies and not on a systematic basis. As opposed to third sector organisations, for-profit operators are not that dependent on grant funding, as they are usually larger and have access to more diverse pools of debt, combining grants with bond instruments and equity. However, financing needs among for-profit operators have historically remained too low to access capital markets directly through own-name bond issuance. One of the largest for-profit operators mentioned its intention to release a green bond, as is the case in other European countries (Fernández et al. 2023).

[8] More detail at: https://www.icf.cat/ca/productes-financers/prestecs/icf-habitatge-social.

> There's two requirements for issuing bonds with social and green labels. On the one hand, you need projects that are adapted to the technical criteria, the Next Generation Funds [European subsidies] help with this. On the other hand, you also need volume to generate a large enough ticket that makes emitting a bond feasible. — CEO, Large for-profit SHO

This relatively large company is receiving a direct grant from the EU's Next Generation Funds for a similar land-lease PPP in a different region, in exchange for meeting higher environmental standards and reducing rents. The viability of such projects depends on grant funding and on the project being large enough to access capital markets directly. While green bonds can potentially lower borrowing costs (Fernández et al., 2023), the associated administrative expenses make them feasible only for large-scale projects. This underpins the need for financial aggregators to pool the needs of various providers. Moreover, smaller operators, particularly non-profits, report that the combined burden of meeting environmental standards and reducing rents compromises the viability of certain projects. As illustrated in Fig. 7, the rent level required by the Next Generation Funds (7.5 EUR per square meter) significantly lowers the project's internal rate of return (IRR).

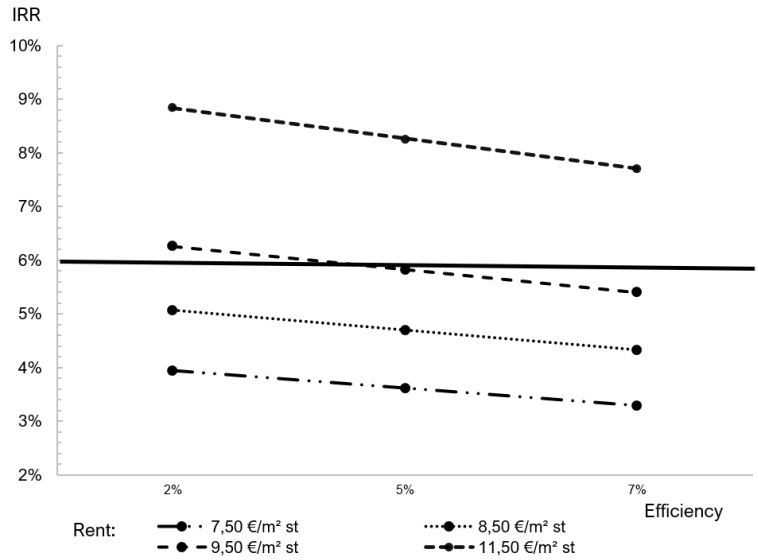
Borrowing costs are also related to resident eligibility and arrears through risk assessments. Due to the rent levels required for financial viability, PPP projects tend to have higher income criteria for resident eligibility compared to publicly managed housing. This often leads to a form of cream-skimming, where private operators house residents with higher incomes. "Our clients are couples, young families with income between four and five and a half times the IPREM,[9] which is the majority of Spanish society" (CEO, Large For profit SHO). In contrast, projects directly managed by public agencies have lower eligibility requirements and often operate at a loss, with the Agencia Habitatge de Catalunya (AHC) covering the costs of non-paying tenants, as highlighted in interviews. Therefore, the viability of these land-lease PPPs depends heavily on the negotiation of eligibility criteria between the administration and the private operator.

As shown in Fig. 8, arrear allowances affect the viability of social housing developments, though they are less impactful than borrowing costs. Arrears significantly influence risk perceptions among lenders, which can lead to higher interest rates. Although local authorities often have ad-hoc agreements to cover the losses in social housing projects, there is no regional or national housing allowance scheme in place. "With [arrears], local authorities collaborate with us to find a suitable resolution. (. . .) However, from a financial point of view, we cannot describe this as a norm, is it not a model." (Director of Development, Not for profit Provider).

Next to the challenges put forward on viability and borrowing costs, fiscality also hinders the development of social housing in land-lease PPPs. This is a consequence of the VAT exemption of rent which precludes passing on the construction VAT to the residents and increases the upfront costs of the provider. While the administration is prevented from selling land, contradictorily, the fiscal framework penalises rental

[9] Indicador Público de Renta de Efectos Múltiples IPREM is a public indicator of income. The ceiling to access social housing is 5.5 times the IPREM.

FIG. 7.8 Sensitivity Analysis of Efficiency (Arrears + Vacancy), and Rent on IRR.



Source: Prepared by the authors.

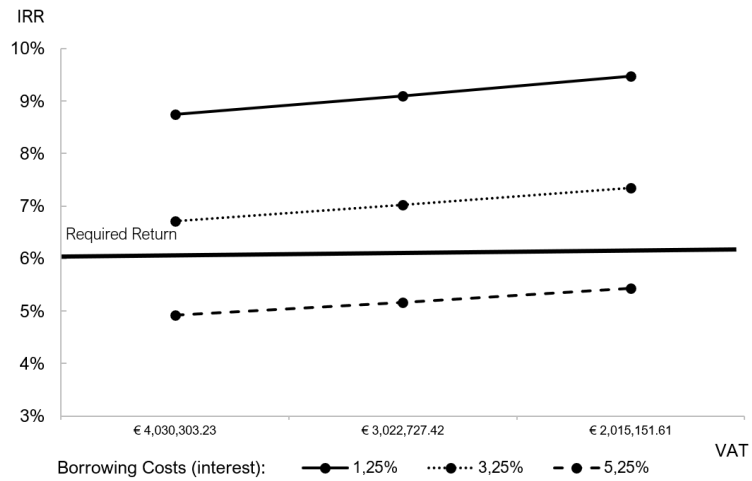
housing developments.

> If a developer sells the property to the final occupier, the developer can pass on VAT to the final occupier. In this transmission, the developer compensates for the VAT charged on the first transmission, that is the public administration and reduces costs. SHOs do not sell so they cannot pass on the 21% or the 10% construction VAT. — Consultant for Private Partners in PPPs

As illustrated in Fig. 9, fiscal costs significantly affect the financial viability of social housing projects. Although VAT has a lesser impact than borrowing costs, it occurs during the construction phase, thereby increasing up-front expenses. Recent changes in corporate taxation have also led to higher corporate taxes for commercial social housing landlords. However, Spain retains a 0% tax on REITs' dividends for investors based abroad (Gil García & Martínez López, 2023). Contradictorily, investment in social rental property by for-profit companies with an interest in maintaining a social housing stock is fiscally penalised while the extraction of dividends by foreign companies remains untaxed.

> Before we used to have an 85% reduction on corporate tax, where instead of 25% you used to pay 3.75%. If you paid dividends, the receiver had to pay 50%, that is an additional 12.5%, resulting in an effective rate of 15%. In 2022, the fiscal code reduced the 85% reduction to 40%, this resulted in an effective rate of 15%. Once you add the 12.5% on dividends, this results in more than 25%. — CEO, Large for-profit SHO

FIG. 7.9 Sensitivity analysis VAT & Capital Costs on IRR. Source: Prepared by the authors.



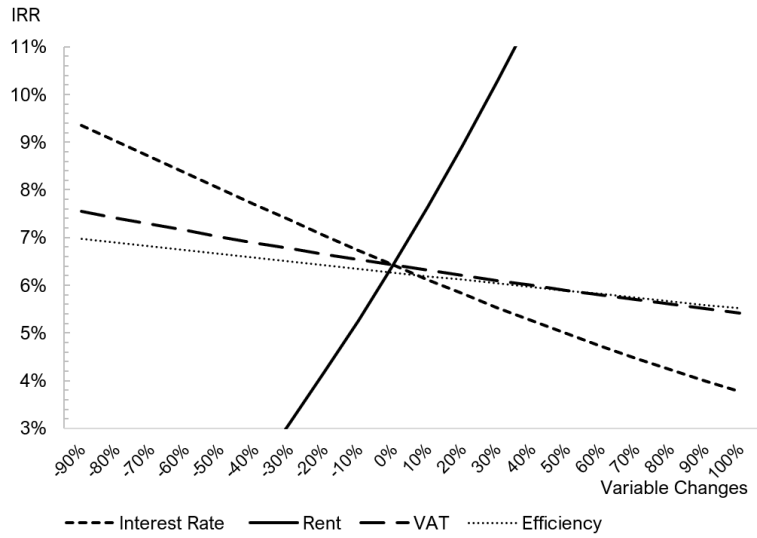
Source: Prepared by the authors.

Fig. 10 shows how not all parameters produce the same impact over viability. While rent levels and borrowing costs have a very noticeable impact on the IRR, arrears and VAT have less influence. However, the parameters presented in Fig. 10 are not exogenous; for example, resident arrears produce a strong impact on risk premiums and hence on borrowing costs. Furthermore, there are structural factors that go beyond the project analysis reflected in the DCF model such as corporate taxation. Also, the small number of specialized organisations in the development and management of social housing, as well as the high leverage of the existing ones, produce inefficiencies that preclude the sector's development.

> They [developers] assume the developer risk and once the building is there they want an 18% return. If the Spanish developer does not have access to capital they go to a fund, probably from London. A value-add fund would front the capital and ask for a similar return. The fund and the developer put together a joint venture and the first stays as a manager that takes 6 to 8%. — CEO, Large for-profit SHO

The lack of vertical integration – meaning the consolidation of financing, development, and operation of social housing under one organisation – as seen in the large specialized social housing organisations (SHOs) in Northern Europe discussed in the literature, also leads to reduced competition among bidders.

FIG. 7.10 Sensitivity analysis IRR Key Parameters.



Source: Prepared by the authors.

7.6 Discussion and Policy Implications: an Unfinished Paradigm

This paper has examined the regulatory framework governing social housing development through land-lease PPPs in Spain. These partnerships rely on planning legislation to obtain public land which is subsequently developed by a third party operating under market conditions. Our research shows that while land has become available for new social housing developments, the lack of an adequate social housing financing model continues to hinder provision.

The literature frequently critiques PPPs for facilitating corporate capture of public funds and profits, particularly in the years leading up to the Global Financial Crisis (GFC) and during the subsequent expansion of REITs (Wijburg et al., 2018). In contrast, Spanish PPPs date back to the 1950s, well before the post-1990s privatisation of housing stock seen in Northwestern Europe. Contemporary land-lease PPPs in Spain differ significantly from the privatisation-driven models described in Janoschka et al. (2020). Spain's new housing legislation prioritizes preserving public land and increasing social housing supply, with rent caps during the leasing period and the eventual return of assets to public control, further distinguishing these PPPs from corporate-led privatisation models, such as those

that provide fiscal benefits to REITs (Gil García & Martínez López, 2023).

This paper highlights three primary barriers to social housing provision in this model: high borrowing costs, a misaligned fiscal regime, and the lack of systematic resident support. Borrowing costs constitute the main hurdle in social housing initiatives and highlight the need for a financial mechanism to deliver capital at scale. Although limits to public expenditure have been engrained in national legislation by many European countries, Off-Budget Agencies (OBAs) excluded from these ceilings have also become increasingly common. In the Netherlands, a guarantee fund, WSW, ultimately backed by the government, allows SHOs to access debt at sovereign rates substantially reducing borrowing costs (Elsinga & Wassenberg, 2014). OBAs have also become increasingly common in Germany to deliver, for example, on climate transformation objectives (Deutsche Bundesbank, 2023). Secondly, the deterring impact of Value Added Tax (VAT) and corporate fiscality on social housing runs counter to current international experiences by other OECD countries. Relying solely on temporary tax exemptions for social housing delivery has yielded limited results (Wijburg et al., 2018). However, in the Spanish context, these exemptions could potentially enhance social housing development, with the added benefit that such projects would eventually return to public stewardship, thereby reducing commercialisation pressures. Finally, addressing arrears and providing support to residents requires the establishment of a robust social safety net. In this context, the English housing allowance system emerges as a compelling option, as it fully covers the housing costs of social housing residents facing financial difficulties (Wilson & Barton, 2017). However, as Priemus and Haffner (2017) highlight for the Dutch case, consideration must be given to the implications for public expenditure. For example, the UK currently spends 1.4% of its GDP on this policy—the highest proportion among OECD countries (OECD, 2022).

Drawing from these international experiences and the sensitivity analysis (Fig. 10), this paper offers three policy recommendations to be explored in future research: the establishment of financial intermediaries with public backing, the introduction of a housing allowance, and comprehensive fiscal reforms. While it is possible to point out how these measures would work in theory, further empirical analyses are needed to show how these measures would fit and benefit social housing policies in the Spanish case. Also, in the face of public debt limitations, establishing adequate Off-Budget Agencies to de-risk the debt profile of private partners could be a precondition to surmount the sector's capacity constraints —see for example the German case (Deutsche Bundesbank, 2023). Ultimately, building a social rental housing stock relying primarily on private investment presents significant challenges particularly if the premise is providing housing to lower-income households. Northwestern European countries built their social housing stock between the 1940s and 1970s through substantial public spending. Reproducing this model in Spain without a similar increase in public expenditure is a manifestly difficult task.

When it comes to limitations, this study draws heavily from a specific land-lease PPP, which constitutes a significant constraint. Although the interviewee sample includes relevant actors beyond Catalonia and the issues identified are acknowledged across stakeholders, additional comparative research on social housing projects in Spain is

necessary for more robust conclusions. Furthermore, while the financial model adds value by illustrating policy impacts on housing development viability, there are two significant limitations. First, the variables considered are not endogenous, meaning for example that arrears significantly affect lending risks and hence borrowing costs. This relationship is not incorporated in the model as the variables are imputed separately. Second, the parameters used are highly deterministic and could benefit from refinement through probabilistic methods like Monte Carlo simulations. As a result, further analysis into the determinants of social housing supply remains a pressing need.

7.7 Conclusion

Spain has historically relied on private partners for housing provision due to financial constraints. In the second half of the 20th century, Spain's urban development was characterised by substantial private investment and the strengthening of state intervention through development levies being progressively embedded in national legislation. However, Spain diverged from other European countries by emphasizing homeownership particularly early on. Recent legislative initiatives have departed from this historical trajectory by reorienting housing policy towards the expansion of social rental housing. However, these efforts grapple with resource constraints and often resort to public-private partnerships (PPPs) reminiscent of legislation introduced in the 1950s.

Our research shows that the recent provisions aimed at preserving public land lack accompanying financial mechanisms to ensure social housing delivery. Public incentives are limited and a comprehensive government scheme that guarantees and pools financial needs for the sector is yet to be established. This results in high borrowing costs that rely on irregular government subsidies and hinder financial viability. Furthermore, the absence of a social safety net to support tenants leads to stringent eligibility criteria resulting in cream-skimming outcomes. The most well-off tenants are housed by for-profit operators while public ones deal with those on lower incomes. Thirdly, the fiscal framework is misaligned with social objectives, as VAT cannot be deducted for new construction, and for-profit operators face heavier corporate taxation than free-market REITs lacking any social objective.

All in all, the Spanish model presents a relevant advantage with respect to other countries, namely that after the concession period both land and housing revert to public stewardship. Eventually, this should contribute to enlarging the social rental stock. This stands in stark contrast to, for example, the German model where once the subsidised loan is repaid, rent and allocation limitations are lifted leading to privatisation and the reduction of the socially rented stock (Droste & Knorr-Siedow,

2014). Ultimately, this paper contends that private investment can lever limited public sources and does not entail the foregoing of social objectives. However, together with financial incentives, policies must incorporate safeguards to prevent privatisation and be financially sustainable, ensuring that public assets, including land and capital, continue to serve the public interest.

Finally, as a methodological takeaway, this paper shows how broadening the scope of housing policy analysis to explicitly integrate insights from financial models can offer valuable insight for policymaking. By combining these models with institutional research on the underpinnings of social housing provision systems, the field can gain empirical depth through particular case studies. Future research on the Spanish context would benefit from exploring the interlock of critical theoretical paradigms with further refined quantitative evidence. As gaining a deeper understanding of the dynamic housing landscape is key to identifying opportunities for reform.

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8 Conclusion

This final chapter begins by drawing conclusions in relation to the research questions posed in Chapter one as well as formulating an overall response to the main research question. Section 8.1 outlines the key scientific and societal contributions of the thesis as well as points out policy recommendations. The final subsection reflects on the main limitations and presents suggestions for future research.

8.1 Answers to the Research Subquestions

"How do house prices affect household consumption across age, tenure, and energy efficiency standards?"

Older homeowners, who are more likely to own their homes outright increase consumption as house prices rise. In contrast, middle-aged households, often renters or mortgage holders, show a negative response compared to older ones, likely due to the higher costs of upsizing or mortgage entry. Younger households display a moderately positive consumption response, possibly reflecting co-movement with house price trends. Energy efficiency plays a particular role; while energy-efficient homes typically correlate with reduced overall consumption, their interaction with rising house prices and older age groups suggests increased consumption due to property premiums. This essay argues that framing the energy transition in housing solely as a technological challenge—focused on energy savings and upgrading costs—overlooks broader distributional implications. Specifically, this framing fails to account for how property appreciation can influence housing affordability and living conditions as reflected by consumption patterns.

"How does decarbonisation impact housing costs across different tenures?"

This essay applies matching and difference-in-differences (diff-in-diff) techniques to a Dutch household longitudinal dataset spanning 2018–2021. It identifies tenure-specific impacts, showing that outright homeowners experience the largest relative reductions in housing costs (10.3%). Mortgagors see the greatest absolute cost reductions due to higher baseline expenses but face smaller proportional gains (5.4%). Social renters achieve moderate reductions (6.9%), reflecting the stability of regulated rents, while private renters show a smaller benefit (5.8%), partially due to rent increases and lower initial consumption. The study also explores welfare implications, highlighting unequal benefits where homeowners gain from cost capitalisation, whereas renters often face diminished welfare due to rising property values. This analysis emphasises the complex interplay between tenure types and energy efficiency interventions in shaping housing affordability.

“How do the financial incentives and distributional impacts of housing renovation policies vary across different tax scenarios?”

This paper employs hedonic regression to identify green premiums associated with energy-efficient renovations and combines this with a distributional analysis of housing costs under two simulated policy scenarios in the Netherlands: (1) the current subsidy model and (2) a proposed green property tax model. The findings highlight that subsidies predominantly benefit higher-income households, who are more likely to own, thus reinforcing the existing regressiveness in housing taxation. In contrast, the green tax model offers a more equitable approach by linking fiscal incentives to energy efficiency, enhancing the financial viability of renovations while addressing disparities in housing cost burdens. This approach is particularly significant when considering user costs, which encompass changes in housing affordability resulting from renovations. The green tax model achieves reductions in user costs that align with energy efficiency improvements through tax savings. Conversely, subsidies reduce upfront renovation costs, but their benefit distribution skews toward wealthier homeowners. Ultimately, green taxes present a sustainable strategy to balance social equity and environmental objectives by integrating progressive environmental considerations into housing fiscal policy.

“How does SSK position the Croatian housing market within the national strategy for economic growth and social policy provision?”

Through interviews with relevant stakeholders, descriptive data indicators, and a review of policy documents, this paper characterises the Croatian growth strategy as a form of small-scale financialisation that relies on aligning social policy —specifically housing subsidies— with mortgage markets. The paper argues that this policy’s impact on housing markets is twofold. First, the SSK reinforces a shift towards financialised growth through increased asset prices. Second, this subsidy shifts the focus of social policy towards mortgage markets, thereby furthering the privatisation of the welfare state and favouring middle-income groups. This paper’s contribution resides in critically discussing the SSK beyond its stated goals and contextualising it within the broader model of economic growth dependent on private finance.

“How does the introduction of ESG legislation affect the financing of social housing decarbonisation?”

This paper identifies three key contradictions between ESG finance and social housing decarbonisation relevant across five European countries to different extents. First, while ESG legislation expands reporting requirements, it delivers limited additional financing and does not consistently reduce interest rates in contexts with guarantees and strong state support. Second, stricter energy efficiency requirements raise capital expenditures, creating tensions with social housing organisations’ (SHOs) mission to provide affordable housing, as rent caps limit their ability to recover these investments. This impacts SHOs’ capacity to maintain lower rents and build new homes, varying significantly across providers and countries. Third, ESG-driven capital market reconfigurations favour social housing systems with strong government backing or larger commercial providers. Practices like portfolio financing and the need for extensive data create an uneven playing field, where well-resourced SHOs in certain countries are better positioned to access green investments.

“How does the interaction of institutional dynamics and financial constraints influence the provision of social rental housing in Spain?”

Through semi-structured interviews and sensitivity analysis of cashflow model parameters, this chapter shows that recent provisions to preserve public land lack the financial mechanisms needed to ensure social housing delivery by private

providers in Spain. It identifies three key barriers: high borrowing costs, a misaligned fiscal regime, and inadequate resident support. High borrowing costs are the primary challenge, as limited public incentives, and the absence of a comprehensive government scheme to pool and guarantee sector-wide financing hinder financial viability, leaving social housing reliant on inconsistent subsidies. Additionally, the lack of systematic support for tenants results in stringent eligibility criteria, leading to "cream skimming," where for-profit operators house higher-income tenants while public providers deal with lower-income residents. Finally, the fiscal framework is at odds with social goals, as VAT on new construction is non-deductible, and for-profit operators face heavier corporate taxes compared to free-market REITs, which operate without social obligations.

8.2 Conclusion

In addressing the main research question, How does decarbonisation affect housing provision and the distribution of housing costs in Europe?, this section explores two key themes introduced earlier: distributional effects at the household level and policy implications for social housing provision systems. This division stems from two bodies of literature that have pointed out both the relevance of inequality measurements across households, and the problematisation of strategic choices at the system level. Most of this section is devoted to presenting research findings within these two axes as well as across them. Finally, the section concludes by suggesting pathways for progressive housing decarbonisation policies.

8.2.1 At the household level

This thesis has contributed to the academic literature with empirical analyses of housing affordability at the household level, employing three measures—consumption, user costs, and direct costs—to reveal significant inequities across housing tenures. Homeowners, particularly older generations, have disproportionately benefited from rising property values and fiscal frameworks favouring ownership. Conversely, younger households and renters face challenges in securing affordable housing. These disparities are the result of deliberate policy choices that have shaped housing markets to privilege property ownership and wealth accumulation, leaving renters at a systemic disadvantage.

Results indicate that current decarbonisation policies intensify these tenure-based

inequalities rather than mitigate them. Consumption-based measures of housing affordability (Chapter 2), which assess living standards, yield results similar to those derived from direct cost indicators (Chapter 3). Homeowners benefit most from renovations, enjoying reduced energy costs and increased property values. Renters experience some cost reductions, but these gains are comparatively modest, reinforcing inequalities in housing cost distribution (Chapter 4). Inequitable housing markets underpin decarbonisation efforts that frequently rely on regressive consumption-based carbon taxation and subsidies targeting clean technologies for homeowners (Borenstein & Davis, 2016). By upholding existing cost structures and neglecting broader distributional inequities, these policies perpetuate housing cost burdens that disproportionately impinge on renters and low-income households.

Aligned with the ethical stance outlined in the introduction, a progressive transition would explicitly address the unequal distribution of housing costs. This thesis proposes to do this by mobilising existing property values to finance decarbonisation. The housing reform literature has proposed various pathways for redistributive change, for instance, detailing fiscal frameworks to address systemic tenure imbalances (Haffner, 2003). Building on Muellbauer's (2023) concept of a joint land and energy efficiency tax, this thesis demonstrates how taxing income from housing wealth can establish more equitable renovation incentives than subsidies for homeowners (Chapter 4). The analysis of the distributional impacts of energy efficiency-linked property taxes highlights opportunities to integrate environmental objectives with efforts to reduce inequalities. This approach addresses systemic tenure imbalances and the chronic undertaxation of homeownership (Pawson, 2024). Ultimately, it proposes leveraging housing wealth to ensure that those who benefit most from rising property values bear greater responsibility for advancing decarbonisation. In the absence of such measures, housing markets—already skewed in favour of homeowners (Fatica & Prammer, 2018)—risk further entrenching regressive outcomes.

Echoing Stiglitz´s et al. (2023) critique of carbon taxes as the silver bullet for the energy transition, this thesis emphasises the importance of context-sensitive approaches grounded in empirical evidence and the complexities of the housing market. Housing markets are inefficient, characterised by inelastic supply, and regulatory distortions. Yet, they also contain levers for progressive change through fiscal reform. Decades of wealth accumulation in property have created a reservoir of capital that can be mobilised to foster equitable and sustainable housing provision. The focus on consumption taxes the EU countries have followed over the last decade (Maier & Ricci, 2022) has had regressive distributional effects impoverishing lower incomes and younger households while protecting the asset values of the wealthy. This trajectory can be reversed by prioritising structural realignments that redirect incentives towards more productive and socially beneficial uses of capital. Reversing this trajectory requires significant intervention, including reconfiguring housing provision to reduce the privileging of homeownership as a vehicle for wealth accumulation. However, the ideological alignment of homeownership with middle-class financial interests entrenches resistance to progressive policies and taxation reforms. Ultimately, the extraction of wealth from the built environment remains deeply embedded in societal expectations about the life cycle, complicating

efforts to build public support for progressive measures.

8.2.2 At the national level

This thesis has expanded the academic literature with three analyses of different modes of housing production and financing, examining legislative changes at both national and EU levels. As presented above, decarbonisation policies are being implemented within national housing provision systems that prioritise homeownership. This prioritisation reflects economic strategies where property value appreciation is leveraged as a driver of growth. The Croatian case (Chapter 5) exemplifies this trend, where housing policy—much like in the UK (Chapter 2)—has focused on subsidising homeownership. While this approach has bolstered property prices, it has also led to deteriorating housing affordability, illustrating the unintended consequences of such policies (Kunovac & Zilic, 2021). These findings underscore the broader challenge of balancing economic objectives with social equity, as homeownership-driven strategies often exclude vulnerable populations and exacerbate inequality.

The subsidisation of homeownership showed at the household level in Part I and in the Croatian case (Chapter 5), contrasts with the reduced direct support for social housing organisations. These organisations increasingly operate under market-driven conditions and rely on private finance which can complicate delivering on their social objectives (Wainwright & Manville, 2017) (Scanlon et al., 2014). Across Europe, social housing organisations are expected to meet decarbonisation objectives with market finance, often facing stricter renovation requirements than homeowners (Chapter 6). The latest iteration in market financing, ESG, introduces reporting obligations without always delivering proportional interest reductions. Finance mechanisms specific to social housing like guarantees complicate the capacity of ESG to produce lower-cost financing. As a result, strict energy efficiency mandates weaken social housing organisations' ability to balance affordability and new construction. Ultimately, ESG-driven capital markets favour large, well-supported housing providers, disadvantaging smaller providers or less structured provision systems.

Less established social housing provision systems face a distinct set of constraints. In the Spanish case, these become more evident in the lack of financial mechanisms and providers able to deliver social housing at scale (Chapter 7). The Barcelona example highlights how recent legislation aimed at preserving public land are not accompanied by the necessary financial mechanisms to ensure the delivery of social housing. The findings emphasise the need to align financial incentives with broader fiscal and social policy objectives to foster the development of a robust social housing sector. Ultimately, the significant variations in social housing structures across Europe (Chapters 5 and 6), reveal the complexity of balancing financial and social objectives within intricate financing models. Government intervention plays a

pivotal role in creating the conditions necessary for housing social housing development and renovation. Instruments such as fiscal policies, direct investment, and the establishment of strong public institutions are essential to ensuring that resources are directed toward projects that are both socially equitable and environmentally sustainable.

In short, European decarbonisation policies often tend to benefit wealthier households through subsidies and consumption-based carbon taxes. Meanwhile, social housing providers, who are tasked with serving the most vulnerable populations, are constrained by market financing, which often prioritises profitability over social impact. The reliance on market mechanisms to address both housing and decarbonisation challenges overlooks the inherent limitations of such approaches when applied to both environmental and social objectives. Without robust public institutions to mediate these systems, a focus on market-driven strategies risks entrenching housing inequalities. These disparities ultimately underscore the pressing need to treat housing affordability and energy efficiency as interlinked challenges requiring comprehensive solutions.

8.2.3 Across levels and disciplines

The particular structuring of this thesis through both sections and parts also allows a reading of the dissertation's findings across household and national scales to present a broader picture of housing policy and decarbonisation. While this thesis is not systematically comparative, it does allow the identification of common trends across different contexts by drawing on various types of evidence often not considered alongside each other. In doing so, this thesis proposes a transdisciplinary approach to housing and renovation that relies on the juxtaposition of findings from different disciplines that come together through their shared topical focus.

This first section A, The Set-Up, defines a structure that is followed by the rest of the thesis, where findings contributing to the more critically oriented housing literature dialogue with quantitative ones, drawing from more orthodox economic approaches. The analysis of homeownership subsidisation in Croatia, drawing on heterodox economic approaches, (Chapter 5) delves into the rationale of property appreciation as a deliberate component of national growth policy. This qualitative paper can be read alongside the quantitative evidence regarding consumption smoothing over the life-cycle (Chapter 2). This last topic is ingrained in orthodox macroeconomics, drawing on regression analysis and large survey datasets. Despite the disciplinary opposition between these approaches, in presenting findings from the two chapters together, this thesis offers a point of encounter between the study of policy rationales and the distributional impacts of price appreciation. Taken together, these chapters show the centrality of housing wealth for growth and consumption. The two papers in this section argue that dependence on housing price growth and the accumulation of housing wealth in particular segments of society constitutes the base over which

housing decarbonisation policies operate. These papers underscore the necessity of interrogating both normative justifications and distributional outcomes to assess decarbonisation measures that ultimately rest on already unequal housing markets.

TABLE 8.1 Thesis' Structure

Part 1: Affordability and Costs	Part 2: Provision and Finance
Section A: The Set-Up. Housing Prices, Impacts and Rationale	
Chapter 2 Investigating the impact of housing price increases on consumption: heterogeneity by age, tenure, and housing quality	**Chapter 5** The Role of Mortgage Subsidies in the Croatian Economic Growth Strategy: a Political-Economy Approach to the SSK
Section B: Current Policies. Decarbonisation and Inequality	
Chapter 3 Unequal rewards to decarbonisation: a diff-in-diff approach to measuring housing costs across tenures	**Chapter 6** Three contradictions between ESG finance and social housing decarbonisation: a comparison of five European countries
Section C: Alternative Pathways	
Chapter 4 Subsidies or green taxes? Evaluating the distributional effects of housing renovation policies among Dutch households	**Chapter 7** When Land is Not Enough: Attracting Private Investment to Expand Social Rental Housing in Spain

Section B, Current Policies: Decarbonisation and Inequality, focuses on the unequal impact of decarbonisation—whether at the household level, where reductions in gas consumption lead to varying cost savings across different tenures, or at the national level, where social housing financing mechanisms and Social Housing Organisations (SHOs) face differing hurdles in accessing sustainable finance. The two essays, Chapter Three and Five, draw again from quantitative analysis, through a quasi-experiemental approach, and from a qualitative approach framed through critical theory (Aalbers,2022). The takeaway from this section is that common transitional strategies, such as the attainment of decarbonisation through carbon taxes and subsidies for homeowners, and the roll-out of sustainable finance across Europe, often impinge on those who are the least well-off whether that is private renters or small social housing providers. In adopting financial market logics, and not incorporating dimensions linked to housing tenure and wealth disparities in the design of decarbonisation pathways, European countries are perpetuating the inequalities that section A pointed out. The main take-away from this section is that without explicit attention to tenure and wealth disparities, as well as national institutions, decarbonisation initiatives risk reinforcing divides along property lines.

Section C, Alternative Pathways, explores alternative policy desing for a progressive transition. Simply put, European countries, as highlighted by many reports and cross-country surveys, are focusing on subsidies for homeowners, often not means-tested; and on market-based, often sustainable, finance for social housing providers. The policies studied, renovation grants for homeowners and debt for social housing provision, are common to both the Netherlands and Spain. The Dutch social housing financing system, covered in Chapter five, results in subsidised credit for SHOs, while grants are available for homeowners as presented in Chapter Seven. In Spain, the EU's Next Generation funds replicate a similar pattern, 4.500 million euros

were destined to homeowners' renovations through grants, while a similar amount was earmarked as loans for social housing rehabilitation, just 1.000 million were provided in the form of grants (Real Decreto 853/2021). This section questions this recipe for housing policy. In working out the distributional effects of a Muellbauer-inspired land-value tax for the Netherlands, Chapter Four proposes to mobilise the wealth accumulated in housing to fund the energy transition. This essay is essentially a viability study of large-scale renovation in the Netherlands. This chapter relates to the study of social housing development in Barcelona, Chapter Seven, through their common illustration of the impact of different housing policies on the financial viability of renovation and development respectively. Similarly to Chapter Four, Chapter Seven, assesses the viability and social impact of a land-lease PPPs, one of the most common strategies for affordable housing provision currently being implemented in Spain. In presenting Chapter Four alongside Chapter Seven, a picture emerges: decarbonisation efforts often rely on two tools—value-enhancing, non-repayable grants for homeowners and subsidised loans for affordable housing provision.

Ultimately, the systematic assessment of the equity implications of housing decarbonisation comparatively across Europe is hindered by data availability, addressed in the limitations section. Further empirical research is needed to define anything close to a housing decarbonisation regime or regimes across Europe and to fully tease out the implications of the energy transition for housing provision. For instance, one can anticipate that the distribution of property ownership is likely to affect the equity implications of subsidies and grants across contexts. Working within these limitations, through the assessment of decarbonisation policies from a housing perspective, this thesis has questioned the most common approaches to housing renovation finance. In doing so, it calls for a strategic realignment of housing policy: to move away from the subsidisation of homeownership and the under-incentivisation of social housing provision, and towards the taxation of property and the creation and strengthening of genuine social housing provision systems. This change is of particular relevance because of its potential to harmonise equity with environmental objectives and boost support for the sustainable transformation of the built environment.

8.3 Contributions and Policy Recommendations

8.3.1 Scientific contributions

The primary scientific objective of this thesis has been to bridge the gap between environmental and housing research by integrating decarbonisation into the study of

housing affordability and provision. This thesis offers three types of scientific contributions. The first consists of filling in substantive gaps in the literature by analysing new housing policies and financial frameworks. The second type of contributions are methodological advancements by employing innovative techniques to analyse energy and housing data. Finally, as a third type of contribution, geared towards epistemology, this thesis also implements a pragmatist approach focused on empirical grounding and transdisciplinary collaboration with partners beyond academia.

First, the thesis addresses substantive gaps in housing policy research by examining new policies and housing financing frameworks. Chapters five, six, and seven focus on diverse new policies: housing subsidies in Croatia, ESG and financial regulations, and national housing policy reforms in Spain. These chapters collectively explore how new housing policies are shaping decarbonisation and provision. Chapter five, develops the financialization literature by analysing the rationale behind the introduction of homeowners' subsidies in Croatia. Following on this chapter, chapter six introduces a particularly novel contribution on sustainable finance analysis, which, to the best of current knowledge, is the first comparative study of ESG financing for social housing decarbonisation. This paper contributes to the literature on social housing finance both by applying a critical framework recently developed by Aalbers (2022), and building onto cross-country comparative studies of social housing finance such as (Norris & Bryne, 2022; Lawson et al., 2022; Scanlon et al. 2014). Chapter 7 also builds on this literature and complements it by adding a mixed-methods case study of a social housing development in Barcelona. In doing so, it responds to a call by Poovey (2015) on the incorporation of analytical tools used by practitioners to assess viability into the study of housing financing.

Second, the thesis also proposes methodological innovations that advance the field of quantitative housing studies. One of the key contributions of chapter two lies in the integration of datasets that combine housing quality metrics with energy consumption data, enabling a more comprehensive analysis of housing systems. By highlighting disparities in energy efficiency and housing stock quality, this chapter provides a foundation for understanding how housing systems contribute to broader patterns of consumption inequality. Chapter three builds on this foundation by challenging traditional, static metrics of housing affordability. Instead, it employs a diff-in-diff model to measure housing costs across tenures in the energy transition. Finally, chapter four draws from user costs to explore housing appreciation through decarbonisation. By combining economic theory with empirical techniques, these chapters propose new empirical approaches to studying housing affordability and decarbonisation. These chapters draw and contribute to the literature on the measuring of housing affordability, namely the work of Haffner & Boumeester (2015) and Haffner (2003), as well as, to the study of housing affordability through panel data, i.e Kang (2023).

Finally, this thesis has also implemented a pragmatist research paradigm. This approach is grounded in empirical observation and committed to transdisciplinary engagement. The objective here was to integrate diverse research traditions—particularly from economics, critical theory, and housing studies—into

an empirically focused analysis. In doing so, the thesis advances an open-ended approach to address intersecting social and environmental challenges within housing systems. Structurally, the thesis moves from historical contextualisation to empirical critique and, finally, to normative proposition, reflecting a layered methodological logic as presented above. The research framework introduced in Chapter One comprises three interlinked components: (A) The Setup, which maps the historical and institutional foundations of contemporary housing policy; (B) Current Policies, offering a critical assessment of existing mechanisms and their limitations; and (C) Alternative Pathways, which explores feasible and equity-driven interventions. This structure is intentionally designed to bridge empirical insights with practical foresight, ensuring the research contributes both to academic research and to policy innovation and systemic reform. By foregrounding empirical validity and transdisciplinary synthesis, this thesis contributes to the development of more adaptive, context-sensitive models of inquiry that are both scientifically robust and policy-relevant.

8.3.2 Societal contributions

This thesis frames housing decarbonisation policies as more than technical energy-saving interventions. Instead, it positions them as mechanisms for reshaping housing provision and redistributing costs and wealth. While this objective has run throughout the thesis, it is most thoroughly developed in chapters three, four and five, which explore the interplay between environmental goals and the pre-existing distribution of housing costs. These chapters deepen the understanding of how decarbonisation can either reinforce or mitigate social disparities. These chapters propose to frame housing renovation policies through social and environmental metrics, developing a more comprehensive understanding to the dual challenges posed by the housing and climate crises. The social relevance of the joint analysis of housing and energy resides in the relationship between housing inequalities and the rise of the far-right referenced in the introduction. By problematising housing and energy together, this dissertation has aimed to shed light over housing inequalities and how these may be poised to increase in the coming decades within the current transition paradigm.

Second, the most tangible societal impact of this thesis is the design and public tender of a PPP project at INCASOL, resulting in the development of over three hundred affordable homes in Barcelona. The research directly informed key aspects of the PPP, including the establishment of evaluation criteria for bids and the selection of private sector partners, included in this chapter's appendix. First, during the design phase, detailed in chapter seven, the project incorporated insights from private partners and public institutions with similar experiences in other Spanish regions. This phase concluded with the formulation of three sets of criteria —maintenance, financial and affordability metrics, and architectural considerations—to analyse private sector bids. Secondly, an external consultancy

project, referenced in the publications list and included in the appendices, was undertaken to cover the finance and affordability analysis section of the bid selection process, and finally propose a private partner to be assigned the plots. By working with housing providers and policymakers, the thesis has directly built capacity for tackling complex housing and energy challenges. The research results have directly equipped external stakeholders with tools to align social housing delivery, affordability and environmental objectives.

Third, beyond its direct applications, the thesis engages with practitioners and policymakers to inform public debates on housing provision and decarbonisation. Chapters five and six were also developed in collaboration with non-academic organisations, such as CERANEO (Croatia) and Housing Europe (Brussels), ensuring the research addressed practical challenges in housing finance and provision. These collaborations have had notable impacts beyond academia, showcased by participation in several practice forums. I was invited to chair a plenary session on "Long-term funding and unlocking finance" at the Retrofit & Strategic Asset Management Summit in London (March 2024), sharing insights with policymakers and industry leaders. Similarly, chapter six was presented at the "Green Finance for Sustainable Development" session organised by the United Nations Economic Commission for Europe (UNECE) Committee on Urban Development, Housing, and Land Management in San Marino (October 2022). Building on the policy relevance of chapter six, together with Professor Michael Peeters, I organised a half-day event on ESG Finance for Affordability at the Department of Management in the built environment that brought together scholars and practitioners from the social housing and finance sectors. These engagements demonstrate the thesis' capacity to inform discourse and influence policy initiatives at both national and international levels.

The final societal contribution of this thesis lies in its emphasis on equity within the housing and energy transitions. This focus is particularly timely, coinciding with the creation of a new EU Commissioner for Energy and Housing. By analysing the distributional impacts of decarbonisation policies, the thesis critiques current approaches that disproportionately benefit wealthier homeowners at the expense of renters and lower-income households. These findings, elaborated in chapter four, were a key element of the author's presentation at the European Commission's DG EMPL Social Situation Monitor event, "The Social Dimension of Housing in the EU", held in Brussels (May 2023). Ultimately, by linking housing affordability with environmental sustainability, this thesis addresses the regressive impact of current housing policies and offers progressive pathways for a more equitable transition.

8.3.3 Policy recommendations

In short, the prevailing approach to achieving net-zero emissions in the built environment relies on increasing energy costs through carbon taxes, subsidising homeowners, and promoting private investment in social housing. While these

measures aim to address environmental goals, they often overlook social dimensions, particularly the growing inequalities embedded in housing systems. This thesis has critically examined this approach in the preceding essays, framing its concerns about the energy transition within progressive proposals for housing reform (Pawson, 2024; Yates, 1989). The recommendations are structured around three shifts in the conceptualisation of housing's role in the energy transition: first, broadening the debate from poverty towards equity; second, the introduction of energy-linked housing taxation; and third, further developing the role of the public sector in guiding investment towards social and environmental objectives.

First, broadening the discussion of social impacts from poverty to equity is essential. Political scientists have consistently highlighted how disparities in housing costs drive support for far-right populism (Ansell & Cansunar, 2021). Yet, instead of addressing the unequal distribution of these costs, EU policy remains anchored on a transition driven by carbon taxes coupled with energy poverty alleviation measures (Maier et al., 2024). This contradictory strategy—mitigating energy poverty on one hand while exacerbating it on the other—prioritises short-term relief over the pursuit of long-term structural solutions to housing inequalities. The failure to address the affordability of housing costs, which constitute the largest expense for most households, deepens existing inequalities. It also ignores the reality that homeowners and landlords are positioned to benefit from the net-zero transition, widening the gap between those with property wealth and those without. A progressive approach would ensure that those who gain the most from the housing system also shoulder a fair share of its renovation costs.

Second, expanding on the previous point, housing and land taxes offer a promising yet underutilised opportunity to leverage housing wealth for renovation financing across Europe. These measures have the potential to mobilise substantial private investment without imposing direct costs on governments. One approach, inspired by Muellbauer's (2023) Green Land Value Tax (GLVT) framework, is developed in chapter four with a proposal tailored to the Netherlands. This entails introducing energy-efficiency-linked taxes on housing wealth, incentivising homeowners to invest in green renovations. Direct housing taxation, however, is just one of several policy tools available. Special assessments, as implemented in the United States (Shoup, 1980), are another relevant financial mechanism. These levies enable property owners to borrow against property values to finance local investments, with repayment integrated into property tax bills. A prominent example of special assessments is the Property Assessed Clean Energy (PACE) program, which has demonstrated the potential to drive significant improvements in energy efficiency. However, PACE has also encountered challenges, including higher tax delinquency rates (Bellon et al., 2024) and concerns over predatory lending practices. These issues have prompted its discontinuation in some jurisdictions (Khouri, 2024), underscoring the need for carefully designed safeguards for renovation policies to succeed in areas with a significant proportion of low-income households.

Finally, policymakers should become aware of the regressive effects of decarbonisation policies and reduce over-reliance on market-based instruments. Current policies, such as carbon taxation and sustainable finance regulations, are

based on two principles: internalising externalities and providing information. These tenets, rooted in addressing market failures, are central to public policy interventions within orthodox economics. These principles, which have guided the public sector since the 1980s, often fall short of delivering optimal outcomes on environmental and social objectives. For instance, as discussed in chapter seven, building social housing—especially in regions with underdeveloped systems like Spain—underscores the necessity of institutional, state-led frameworks to drive investment. Similarly, as explored in chapter six, the European Union's sustainable finance regulations are at odds with the unique challenges faced by not-for-profit housing providers. Addressing these shortcomings may require exploring more stringent legislation of financial markets. Such interventions, as argued by Mazzucato et al. (2023) represent a move towards more prescriptive forms of financial legislation, capable of ensuring that capital flows align with broader social and environmental objectives.

8.4 Limitations and Future Research

8.4.1 Limitations

The selection of research topics in this project was guided by their policy and societal relevance, prioritising a focus on equity issues in the transition to net zero over data availability. This approach ensured that the research remained grounded in real-world concerns but also introduced significant challenges, particularly with regards to data. A key constraint was the lack of comprehensive datasets that consistently captured key variables such as energy consumption, building quality and housing costs for a nationally representative group of households. For instance, the UK collects relevant data on energy and housing, however, these are not integrated within the same dataset. Chapter two overcomes this limitation by merging different surveys and conducting a series of consistency checks to enhance reliability. Similarly, in the Netherlands, EPC data, a major indicator of building quality, is frequently incomplete and outdated, as highlighted in chapters three and four. In these chapters, the research had to be confined to households for which data on both energy consumption and EPC ratings were available, leading to a narrower focus than initially intended. The mixed methods approach helped bridge this gap by complementing quantitative data limitations with qualitative insights that provided a richer contextual understanding of housing conditions and policy effectiveness.

Another significant limitation was the lack of readily available data on specific policy measures, such as the uptake of housing renovation subsidies in the Netherlands. This gap was addressed by employing simulations to assess the distributional effects of various policies. However, these simulations often led to limited descriptive and

exploratory claims, highlighting their role in raising questions about strategic policy decisions rather than providing definitive impact assessments. Enhanced access to granular data would allow for a more robust picture of the effects of housing renovation on wealth distribution and welfare outcomes, enabling policymakers to make better-informed decisions. Furthermore, the use of deterministic parameters was inevitable when teasing out the policy relevance of certain phenomena (Chapters 3, 4 and 7). This resulted in another set of limitations that has been outlined in each chapter and mitigated through different forms of sensitivity analysis, which tested the robustness of findings under different assumptions. For instance, the deterministic parameters outlined in chapter seven, while informed by discussions with interviewees could have been further explored through more advanced simulation techniques.

The second part of the thesis adopted a predominantly qualitative approach, relying on semi-structured interviews. This mixed methods approach helped mitigate the limitations of the quantitative sections by incorporating qualitative insights, offering a richer contextual understanding of housing provision and policy rationale. While semi-structured interviews provide valuable depth and context, they also present specific limitations. For instance, both interviewees and the interviewer may be subject to bias, for example, due to social desirability or personal perspectives. Also, the small number of interviewees limits the generalisability of the findings, particularly when small sample sizes encompass multiple groups or stakeholders across diverse contexts, as is often the case in Part II. In chapter five, these limitations were addressed by supplementing interviews with descriptive statistics of key variables and ensuring the inclusion of a diverse range of stakeholders. Similarly, in chapter six, data were gathered from housing associations of varying sizes and funding sources to enhance representativeness. These methodological limitations are also evident in chapter seven, which focuses on an in-depth case study in Barcelona. Interviewees from different regions across Spain were also included in the sample to broaden the relevance of the results beyond their immediate local context. In this particular case, a more expansive approach —such as gathering quantitative evidence from various social housing projects across Spain— could generate a larger dataset suitable for statistical analysis and more generalisable results. Finally, another limitation to the generalisability of the findings stems from the highly heterogeneous institutional contexts across Europe, particularly at the local level. Moving forward, the incorporation of survey instruments could provide a more comprehensive understanding of the evolving landscape of social housing financing in Europe.

Finally, this thesis has focused on the empirical encounter of different disciplines, from both orthodox and critical approaches, as well as methodologies, qualitative and quantitative. This empirical focus follows a pragmatist approach that emphasises problem solving and empirically focused research in opposition to the advancement of one particular discipline. As a result, the thesis chooses not to develop theoretical propositions but instead focuses more extensively on providing policy recommendations. While choosing this approach puts theorising outside of the scope of the thesis, the need for the integration of housing inequality and sustainability issues becomes evident in finishing this thesis. The conciliation of environmental and

social justice objectives, particularly when it comes to issues related to housing provision, remains a pressing task for housing scholars.

8.4.2 Future research

Throughout the research project, four areas of interest for future investigation have emerged: the environmental impact of new construction, the use of registry data in conjunction with policy-specific datasets, the potential of advanced simulation techniques to assess social housing projects and expanding the comparative scope of the thesis beyond the EU.

First, the environmental implications of new housing supply have increasingly come to the fore over the last years. While new housing supply dampens price increases and improves affordability (Bratu et al., 2023; Mast, 2023), it entails considerable environmental costs. Housing construction objectives often clash with environmental ones such as carbon budgets and no net land take (Decoville & Feltgen, 2023). For example, Dutch organisations have the ambition to build 100,000 homes a year (Kraniotis, 2024). Similarly, the Spanish Central Bank has estimated the size of the housing supply deficit at 225,000 units a year (Banco de España, 2024). Also, the UK government's response to the housing affordability crisis hinges on an ambitious target to construct 300,000 new homes annually. Yet, in the British case, achieving this goal is projected to consume 104% of Britain's cumulative carbon budget for 2022–2050, rendering national emissions targets unattainable (Zu Ermgassen et al., 2022). These projections from the UK highlight the tension between addressing housing shortages and meeting climate commitments, further underscoring the challenges of balancing affordability with sustainability. Emerging research questions include how to optimise land use, allocate carbon budgets effectively, and assess the distributional impacts of curtailing new construction.

Second, building on the discussions in Chapters Three and Four, the growing availability of registry data, particularly when joined with data about specific policies, offers new opportunities to track and model the impacts of housing decarbonisation on costs more precisely. New registry-based longitudinal datasets make possible a detailed understanding of the financial burdens and benefits associated with renovation, shedding light on how costs are distributed across different households and regions. This is especially relevant as the EU Emissions Trading Scheme (ETS2) comes into effect in 2027, introducing new financial pressures on carbon emissions across housing as well as other sectors. Leveraging this data to quantify the economic implications of decarbonisation strategies at both household and sectoral levels presents relevant opportunities for research that can help design effective and equitable interventions.

However, comparative work on these topics remains limited by the lack of common indicators across countries. EU-SILC and the Household Finance and Consumption

Survey (HFCS) do not collect data on building quality across all countries. As a result, comparative cross-country analyses of equity and environmental issues are only now being developed, see for instance, Figure 1.4 in the introduction, reproduced from Maier et al. 2024. These analyses however do not explicitly incorporate data on building quality, an area where even registry data carries limitations, as pointed out in the Data sections of Part I chapters. Progressively, as more countries make their registry datasets available to researchers, following the likes of the Netherlands and Norway, the possibilities for further comparative studies are expanding. For instance, in Spain the recently created ES DataLab aims to make available to researchers microdata from various government sources. Ultimately, the progressive availability of more granular and better quality data is expanding the horizon of research opportunities at the intersection of environmental and social equity topics.

A third area of interest for future applied research lies in the application of more advanced simulation techniques, such as Monte Carlo simulation and decomposition analysis (Kozlova et al., 2016), to evaluate the financial viability of social housing developments. These techniques enable researchers to evaluate the feasibility of housing supply under diverse economic, environmental, and institutional conditions. As mentioned above, this line of research was partially developed in a report produced for INCASÒL, which analysed private sector bids to build social housing on publicly owned land (Appendix Chapter 8). Future research could expand on this foundation by adapting these tools to assess the value delivered to residents, public administrations, and the environment in other contexts. The development of streamlined, user-friendly toolkits for analysis could facilitate the application of these techniques in other contexts where the social housing sector is underdeveloped.

Finally, already ongoing research is expanding the comparative analysis of housing decarbonisation beyond the EU by integrating evidence from the United States. Funded by the Fulbright Commission, this associated project focuses on housing policy in California, with particular emphasis on state-level approaches to decarbonisation. The research pursues two main objectives. First, it builds on the comparative analysis presented in chapter six by incorporating insights from the Californian context into the analysis of sustainable finance in social housing. Second, the project also examines housing renovation strategies centred around taxation, in particular special assessments, such as the Property Assessed Clean Energy (PACE) program mentioned above. By incorporating cases from the US, this ongoing project both enriches the findings presented here and provides a broader framework to assess decarbonisation strategies more globally.

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AI Disclosure

During the preparation of this thesis, the author used ChatGPT4.0 to correct spelling, improve readability and edit LaTeX code, as well as to assist in the translation of the summary. After using this tool, the author reviewed and edited the content as needed and takes full responsibility for the content of the publication.

I Appendices

I.1 Appendix Chapter 2

Predict EPC - Binary logit model & Robustness Checks

TABLE I.1 EPC Prediction

	Dependent variable:
	(EPC_Bin)
(M_Year)2012-2013	0.639***
	(0.031)
(M_Year)2014-2015	0.971***
	(0.030)
(M_Year)2016-2017	0.987***
	(0.069)
(M_Year)2018-2019	1.426***
	(0.069)
(M_HS)2	−0.009
	(0.027)
(M_HS)3	0.037
	(0.034)
(M_HS)4	0.025
	(0.038)
(M_HS)5	0.129**
	(0.051)

(M_HS)6	0.157**
	(0.080)
(M_HS)7+	0.180
	(0.110)
(M_HT)2	−0.319***
	(0.039)
(M_HT)3	−0.009
	(0.037)
(M_HT)4	1.624***
	(0.043)
(M_HT)5	−0.589***
	(0.075)
(M_Ten)2	−0.237***
	(0.046)
(M_Ten)3	−0.317***
	(0.056)
(M_Ten)4	0.267***
	(0.048)
(M_Ten)5	0.787***
	(0.047)
M_Rent	0.001***
	(0.0002)
M_Mort	0.0003
	(0.0002)
M_Inc	0.0001***
	(0.00004)
(M_Age)2	0.005
	(0.056)
(M_Age)3	−0.121**
	(0.056)
(M_Age)4	−0.291***
	(0.057)

(M_Age)5	−0.315***
	(0.058)
(M_Age)6	−0.301***
	(0.058)
(M_Soc)1	0.216***
	(0.080)
(M_Soc)2	0.141*
	(0.073)
(M_Soc)3	0.164**
	(0.082)
(M_Soc)4	0.024
	(0.085)
(M_Soc)5	0.113
	(0.086)
(M_Soc)6	0.148**
	(0.076)
(M_Soc)7	0.033
	(0.077)
(M_Gas)1	1.021***
	(0.032)
Constant	−2.877***
	(0.084)
Observations	62,238
Log Likelihood	−30,844.260
Akaike Inf. Crit.	61,758.530
Note:	*p<0.1; **p<0.05; ***p<0.01

TABLE I.2 Stepwise Regression. AIC by Degrees of Freedom

df	mean	n	df	mean	n
35	61758.57	1	17	66633.96	63
34	62037.53	4	16	66883.73	54
33	62316.66	6	15	67796.60	50
32	62595.50	4	14	68711.83	51
31	63931.74	4	13	68902.64	51
30	64311.15	13	12	68328.99	47
29	64163.73	23	11	67928.18	38
28	63662.23	23	10	69041.04	26
27	63519.64	20	9	71258.23	20
26	65012.99	26	8	71091.18	23
25	65810.34	38	7	70236.83	23
24	65486.36	47	6	69882.61	13
23	65020.57	51	5	70593.26	4
22	65199.62	51	4	73215.22	4
21	65990.02	50	3	73530.94	6
20	66770.50	54	2	73859.98	4
19	67008.88	63	1	74206.15	1

Robustness checks: K-fold Test & Stepwise logistic regression

Generalized Linear Model

62238 samples 10 predictor 2 classes: ’0’, ’1’

No pre-processing Resampling: Cross-Validated (10 fold) Summary of sample sizes: 56015, 56014, 56015, 56014, 56014, 56014, ... Resampling results:

Average Accuracy: 0.7485298 Kappa: 0.2176083

Using a 10-fold cross-validation procedure to determine the ability of the model to generalize to unseen data, we demonstrate that the accuracy remains stable across folds. This indicates that taking different subsets of the data does not lead to different model estimates. In addition, a stepwise logistic regression was performed to estimate the adequacy of the predictor variables for imputing EPC bin in the consumption dataset. The procedure shows the lowest AIC value for the model including all predictor variables. This can be seen as the logistic regression with all variables being a valid way to impute the dependent variable. In sum, the two checks performed support the reliability and validity of the regression results across subsamples and regression specifications.

Full Regression Results 1-4

TABLE I.3 Regression Results

	Dependent variable:			
	log(Non-Housing consumption)			
	EPC	Age Groups	EPC+Age Groups	EPC+Tenure
	(1)	(2)	(3)	(4)
(Year)2011	−0.003	−0.005	−0.004	−0.002
	(0.010)	(0.010)	(0.010)	(0.010)
(Year)2012	0.002	−0.006	0.002	−0.005
	(0.010)	(0.010)	(0.010)	(0.010)
(Year)2013	0.001	−0.009	0.001	−0.002
	(0.011)	(0.011)	(0.011)	(0.010)
(Year)2014	0.008	−0.004	0.006	−0.0004
	(0.011)	(0.011)	(0.011)	(0.010)
(Year)2015	0.009	−0.006	0.005	0.001
	(0.011)	(0.011)	(0.011)	(0.011)
(Year)2016	0.032***	0.017	0.027**	0.020*
	(0.011)	(0.011)	(0.011)	(0.011)
(Year)2017	0.006	−0.011	−0.0002	−0.008
	(0.011)	(0.011)	(0.011)	(0.010)
(Year)2018	0.033***	0.010	0.026**	0.014
	(0.011)	(0.011)	(0.011)	(0.010)
(Year)2019	0.015	−0.011	0.008	−0.004
	(0.011)	(0.011)	(0.011)	(0.010)
Age	−1.170***	−0.464	−0.433	−1.273***
	(0.248)	(0.289)	(0.288)	(0.242)
I(Age^2)	0.343***	0.195***	0.184***	0.347***
	(0.057)	(0.065)	(0.065)	(0.055)

I(Age^3)	−0.044***	−0.030***	−0.029***	−0.043***
	(0.006)	(0.007)	(0.007)	(0.006)
I(Age^4)	0.003***	0.002***	0.002***	0.002***
	(0.0003)	(0.0004)	(0.0004)	(0.0003)
I(Age^5)	−0.0001***	−0.00005***	−0.00005***	−0.0001***
	(0.00001)	(0.00001)	(0.00001)	(0.00001)
N_Children_U_2	−0.005	−0.00004	−0.004	0.004
	(0.010)	(0.010)	(0.010)	(0.010)
N_Children_2_t_5	0.020***	0.026***	0.023***	0.031***
	(0.008)	(0.008)	(0.008)	(0.008)
N_Children_5_t_18	−0.063***	−0.061***	−0.061***	−0.045***
	(0.004)	(0.004)	(0.004)	(0.004)
N_Adults	0.220***	0.230***	0.224***	0.209***
	(0.005)	(0.005)	(0.005)	(0.004)
Dummy_More_2_A1	−0.086***	−0.098***	−0.094***	−0.065***
	(0.010)	(0.010)	(0.010)	(0.010)
Alevel	0.089***	0.091***	0.088***	0.071***
	(0.006)	(0.006)	(0.006)	(0.006)
Degree	0.136***	0.136***	0.134***	0.104***
	(0.005)	(0.005)	(0.005)	(0.005)
EPC_Bin1	−0.180***		−0.180***	−0.049***
	(0.010)		(0.010)	(0.010)
log(Average_Price)		0.002	0.028**	0.026
		(0.013)	(0.013)	(0.016)
Age_G2		0.556***	0.695***	
		(0.207)	(0.206)	
Age_G3		−1.011***	−0.722***	
		(0.210)	(0.210)	
log(Average_Price):Age_G2		−0.043**	−0.054***	
		(0.017)	(0.017)	
log(Average_Price):Age_G3		0.078***	0.055***	
		(0.017)	(0.017)	

Tenure2				0.263
				(0.269)
Tenure3				0.702***
				(0.241)
Tenure4				−0.132
				(0.238)
log(Average_Price):Tenure2				−0.010
				(0.022)
log(Average_Price):Tenure3				−0.036*
				(0.020)
log(Average_Price):Tenure4				0.039**
				(0.020)
Constant	6.544***	5.270***	4.967***	6.417***
	(0.410)	(0.503)	(0.502)	(0.444)
57404.64	57644.77	57297.41	55336.3	
Observations	41,646	41,646	41,646	41,646
R^2	0.178	0.174	0.181	0.218
Adjusted R^2	0.178	0.173	0.180	0.218
Residual Std. Error	0.482 (df = 41623)	0.483 (df = 41619)	0.481 (df = 41618)	0.470 (df = 41616)
F Statistic	410.240*** (df = 22; 41623)	336.266*** (df = 26; 41619)	339.517*** (df = 27; 41618)	400.696*** (df = 29; 41616)

Note: *p<0.1; **p<0.05; ***p<0.01

Full Regression Results 5

TABLE I.4 Regression Results Predicted vs Observed House Prices

	Dependent variable:	
	log(Non-Housing consumption)	
	(1)	(2)
(Cohort)2	0.056***	0.051***
	(0.015)	(0.015)
(Cohort)3	0.104***	0.090***
	(0.020)	(0.020)
(Cohort)4	0.086***	0.057***
	(0.023)	(0.022)
(Cohort)5	0.098***	0.065***
	(0.026)	(0.025)
(Cohort)6	0.129***	0.109***
	(0.029)	(0.028)
(Cohort)7	0.132***	0.127***
	(0.031)	(0.030)
(Cohort)8	0.121***	0.108***
	(0.033)	(0.032)
(Cohort)9	0.091***	0.068**
	(0.035)	(0.034)
(Cohort)10	0.073**	0.045
	(0.037)	(0.036)
(Cohort)11	0.076*	0.053
	(0.039)	(0.038)
(Cohort)12	0.084**	0.067*
	(0.041)	(0.040)
(Cohort)13	0.077*	0.055
	(0.044)	(0.043)

(Cohort)14	0.074	0.032
	(0.058)	(0.056)
Age	−0.501	−0.989***
	(0.336)	(0.305)
I(Age^2)	0.209***	0.295***
	(0.077)	(0.071)
I(Age^3)	−0.032***	−0.039***
	(0.008)	(0.008)
I(Age^4)	0.002***	0.002***
	(0.0004)	(0.0004)
I(Age^5)	−0.0001***	−0.0001***
	(0.00001)	(0.00001)
N_Children_U_2	−0.002	0.005
	(0.010)	(0.010)
N_Children_2_t_5	0.026***	0.035***
	(0.008)	(0.008)
N_Children_5_t_18	−0.061***	−0.044***
	(0.004)	(0.004)
N_Adults	0.225***	0.213***
	(0.005)	(0.004)
Dummy_More_2_A1	−0.096***	−0.073***
	(0.010)	(0.010)
Alevel	0.089***	0.071***
	(0.006)	(0.006)
Degree	0.136***	0.106***
	(0.005)	(0.005)
EPC_Bin1	−0.098***	−0.045***
	(0.015)	(0.014)
Predicted	0.007	0.011
	(0.014)	(0.017)
Age_G2	0.072	
	(0.219)	

Age_G3	−0.140	
	(0.218)	
Tenure2		0.234
		(0.296)
Tenure3		0.303
		(0.253)
Tenure4		0.285
		(0.248)
Diff_Pred_Obvs	0.058	−0.051
	(0.071)	(0.090)
Predicted:Age_G2	−0.003	
	(0.018)	
Predicted:Age_G3	0.009	
	(0.018)	
Age_G2:Diff_Pred_Obvs	0.004	
	(0.091)	
Age_G3:Diff_Pred_Obvs	−0.128	
	(0.090)	
Predicted:Tenure2		−0.008
		(0.024)
Predicted:Tenure3		−0.003
		(0.021)
Predicted:Tenure4		0.005
		(0.020)
Tenure2:Diff_Pred_Obvs		0.174
		(0.124)
Tenure3:Diff_Pred_Obvs		0.097
		(0.106)
Tenure4:Diff_Pred_Obvs		0.001
		(0.104)
EPC_Bin1:Diff_Pred_Obvs	−0.464**	−0.011
	(0.218)	(0.196)

EPC_Bin1:Age_G2	−0.109***	
	(0.022)	
EPC_Bin1:Age_G3	−0.159***	
	(0.024)	
EPC_Bin1:Age_G2:Diff_Pred_Obvs	0.592*	
	(0.327)	
EPC_Bin1:Age_G3:Diff_Pred_Obvs	0.764**	
	(0.353)	
EPC_Bin1:Tenure2		0.041*
		(0.024)
EPC_Bin1:Tenure3		−0.047*
		(0.026)
EPC_Bin1:Tenure4		0.037
		(0.041)
EPC_Bin1:Tenure2:Diff_Pred_Obvs		−0.622*
		(0.365)
EPC_Bin1:Tenure3:Diff_Pred_Obvs		−0.243
		(0.387)
EPC_Bin1:Tenure4:Diff_Pred_Obvs		−0.385
		(0.622)
Constant	5.180***	5.999***
	(0.575)	(0.541)
57306.52		
Observations	41,646	41,646
R^2	0.181	0.219
Adjusted R^2	0.180	0.218
Residual Std. Error	0.481 (df = 41606)	0.470 (df = 41601)
F Statistic	235.448*** (df = 39; 41606)	265.450*** (df = 44; 41601)

Note: *p<0.1; **p<0.05; ***p<0.01

I.2 Appendix Chapter 3

Regression on Treatment

TABLE I.5 Regression Results on Treatment

	Dependent variable:	
	as.factor(Treat_1)	
MLTOTAAL1JAN_2018	0.008***	(0.0004)
Tenure_Def	-0.081***	(0.016)
MLTOTAAL1JAN_2019	-0.021***	(0.0004)
GASVERBRUIK1JAN_2018	-0.001***	(0.00004)
GASVERBRUIK1JAN_2019	0.002***	(0.00004)
MLENETTO1JAN_2018	-0.007***	(0.0004)
MLHNETTO1JAN_2018	-0.007***	(0.0005)
MLENETTO1JAN_2019	0.024***	(0.0004)
MLHNETTO1JAN_2019	0.018***	(0.0004)
QUOTETOTAAL1JAN_2018	0.0001	(0.001)
QUOTETOTAAL1JAN_2019	-0.002	(0.001)
HUURKLASSE1JAN_2018	0.112***	(0.025)
HUURKLASSE1JAN_2019	-0.090***	(0.026)
MLEHYP31DEC_2018	-0.003***	(0.0001)
MLEHYP31DEC_2019	0.00001	(0.00003)
MLHKALEHUUR1JAN_2018	-0.00004	(0.0002)
MLHKALEHUUR1JAN_2019	0.0003	(0.0002)
Res_Age_2019	-0.022***	(0.0004)
Building_Age_2019	-0.001***	(0.0001)
ELEK_2019	0.0003***	(0.00001)
Dwelling_Type_2019	-0.036***	(0.006)
VROMHH1JAN_2019	0.0001***	(0.00001)
P100WELVAART1JAN_2019	-0.010***	(0.001)

	Dependent variable:	
	as.factor(Treat_1)	
BESTINKH1JAN_2019	-0.0001***	(0.00001)
N_Adults_2019	-0.323***	(0.019)
Sqm_2019	0.0003**	(0.0002)
N_Children_2019	0.085***	(0.019)
Constant	3.673***	(0.237)
Observations	361,987	
Log Likelihood	-105,946.300	
Akaike Inf. Crit.	211,948.500	

Note: *p<0.1; **p<0.05; ***p<0.01

Welfare Analysis

The welfare framework relies on disposable income and cost parameters specific to each tenure type (e.g., private renters, social renters, and homeowners) to calculate housing costs, consumer surplus, and changes in welfare due to cost reductions. Let:

- Y represent the average disposable income for each tenure type,
- θ the average income-to-housing-cost ratio, and
- Δ_C the percentage reduction in housing costs.

The initial total housing cost, H_0, for each tenure type is defined by

$$H_0 = Y \cdot \theta,$$

while the post-reduction housing cost, H_1, reflects the cost reduction as:

$$H_1 = H_0 \cdot (1 - \Delta_C).$$

Assume the demand for housing, $D(H)$, is a function of disposable income relative to housing costs:

$$D(H) = \frac{Y}{H}.$$

The consumer surplus, which captures welfare gains before and after the cost reduction, is calculated as the area under the demand curve. Let H_{min} represent the

minimum necessary housing cost. The consumer surplus before the cost reduction, CS_0, is then

$$CS_0 = \frac{D(H_0) \cdot (H_0 - H_{\text{min}})}{2},$$

and after the reduction, CS_1, is

$$CS_1 = \frac{D(H_1) \cdot (H_1 - H_{\text{min}})}{2}.$$

For homeowners, the present value of cost savings S contributes to property value appreciation. Monthly cost savings, S_m, are derived from the initial housing costs and the cost reduction percentage:

$$S_m = H_0 \cdot \Delta_C.$$

Annualized cost savings, S, are given by

$$S = 12 \cdot S_m.$$

To project the cost savings over a period of $T = 20$ years, the indexed cost savings with growth rate g and discount rate r yield the present value PV_S as

$$PV_S = \sum_{t=1}^{T} \left(S \cdot (1+g)^{t-1} \cdot \frac{1}{(1+r)^t} \right).$$

For homeowners, a portion κ of PV_S is capitalised, leading to an increase in property value:

$$P_1 = P_0 + \kappa \cdot PV_S.$$

The utility function, incorporating non-housing consumption C and housing H, is given by a Cobb-Douglas form:

$$U(C, H) = C^{\alpha} \cdot H^{1-\alpha},$$

where α is the elasticity of utility with respect to C. Here, assume $\alpha = 0.7$.

For renters, welfare depends on consumer surplus and is adjusted by disutility from rising property prices. Their total utility before the cost reduction is

$$U_0 = CS_0,$$

and the utility after the reduction, accounting for disutility from rising prices, is

$$U_1 = CS_1 - \alpha \cdot (P_1 - P_0),$$

where α reflects the sensitivity of renters' utility to rising property values.

For homeowners, utility includes consumer surplus and the capital gains from property appreciation. Thus, the total utility before the cost reduction is

$$U_0 = CS_0,$$

and after the reduction, incorporating the capitalisation effect, it becomes

$$U_1 = CS_1 + \kappa \cdot PV_S.$$

The welfare changes by tenure type are derived from the differences in utility before and after the cost reduction. For renters, the welfare change $\Delta W_{\text{renters}}$ is

$$\Delta W_{\text{renters}} = U_1 - U_0 = CS_1 - CS_0 - \alpha \cdot (P_1 - P_0),$$

while for homeowners, the welfare change $\Delta W_{\text{homeowners}}$ is

$$\Delta W_{\text{homeowners}} = U_1 - U_0 = CS_1 - CS_0 + \kappa \cdot PV_S.$$

I.3 Appendix Chapter 4

WoON Dataset

FIG. I.1 National Distribution of EPC

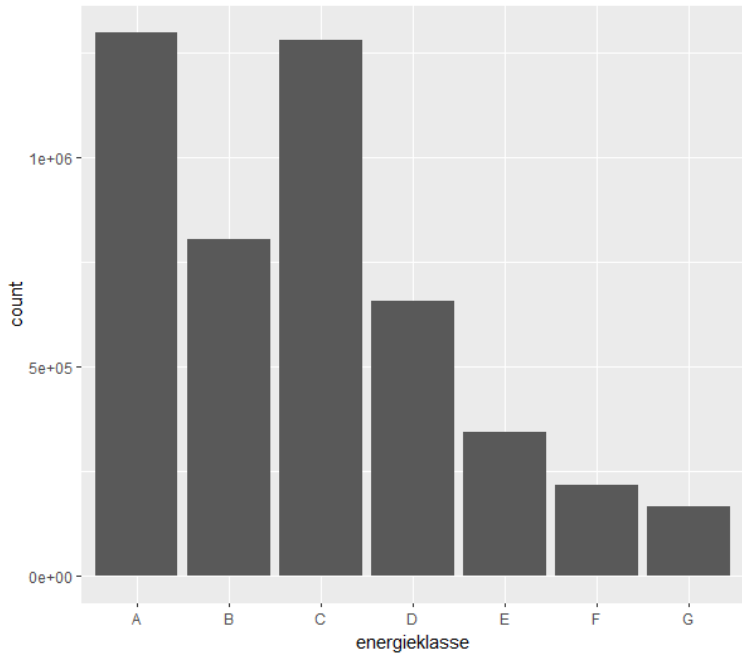
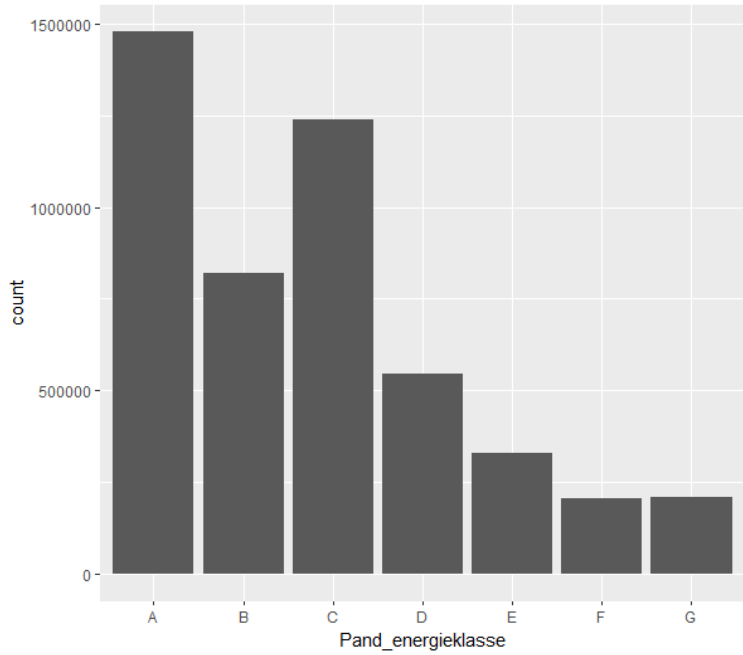


FIG. I.2 EPCs in WoON Dataset



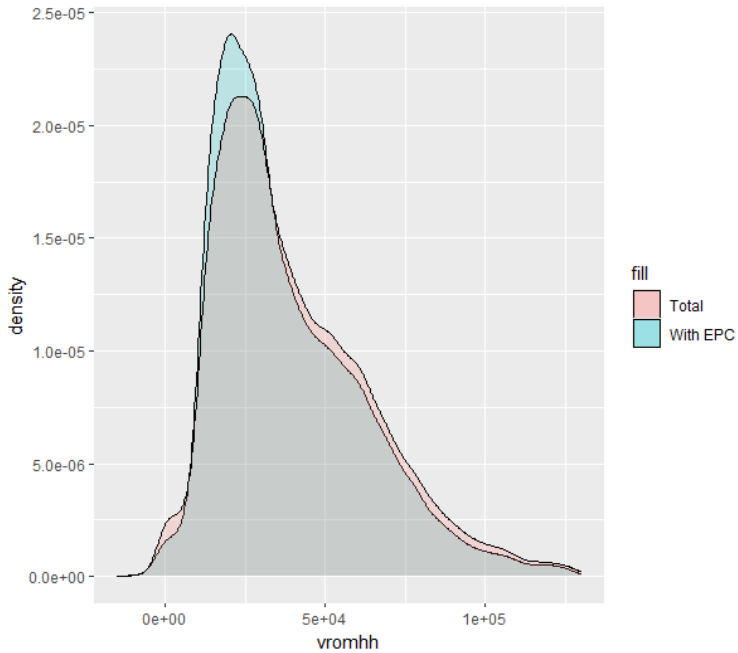
Costs Dataset

Source: TNO & PBL, (2021) Dashboard Eindgebruikerskosten, https://www.expertisecentrumwarmte.nl/eindgebruikerskosten/default.aspx [Accessed November 2023]

TABLE I.6 Costs Renovation

House Type	Cost m2 Ren to B	Cost m2 Ren to D
2 under 1 roof	203.52	81.45
Coner House	210.81	90.20
Semi-detached house and other	192.13	81.69
Free Standing	182.06	74.96
Apartment	217.39	99.55

FIG. I.3 Income distribution with vs without EPC

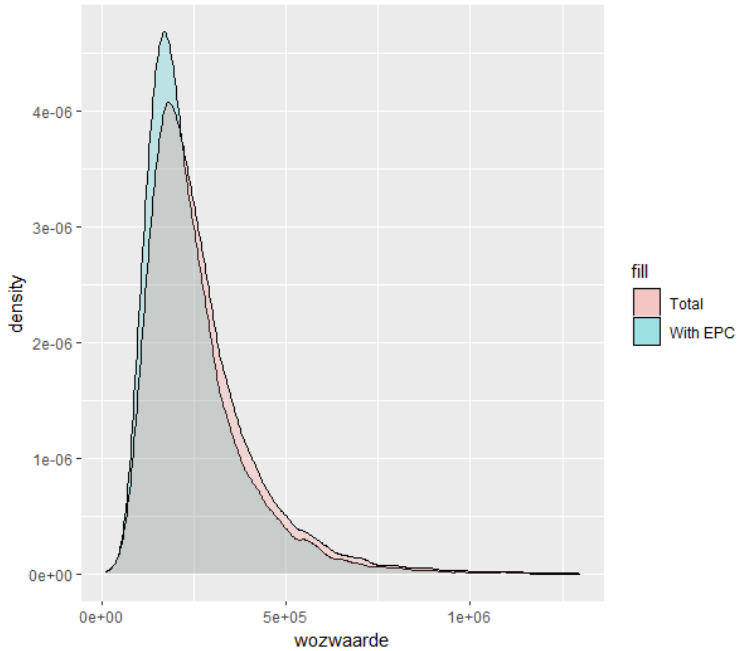


Regression Tests

TABLE I.7 Tests

Test	statistic	p.value
Weak Instruments	11702.63	< 2e-16 ***
Wu-Hausman	38.03	7.07e-10 ***
Note:	*p<0.1; **p<0.05; ***p<0.01	

FIG. I.4 Property Value distribution with vs without EPC



I.4 Appendix Chapter 6

Research questions, data collection and codes

TABLE I.8 Research Questions, Data Collection Strategies, and Codes

Research Questions	Data Collection Strategy	Codes
(1) What are the main underlying differences between social housing financing systems in Europe?	Literature Study	NA
(2) How are reporting and disclosure obligations affecting SHOs' access to capital markets and ultimate borrowing costs?	Semi-structured interview	Financing Models, (Non)Taxonomy Aligned Bond, Reporting & Disclosure, ESG Additionality, Guarantees
(3) How are renovation requirements and MEPS impacting SHOs' social objectives?	Semi-structured interview	Newbuild Compromise, Rent Increases, Renovation Financing Models
(4) How are national management practices and organisation characteristics interacting with "greening" capital markets?	Semi-structured interview	Risks, Social (Taxonomy), Inequalities – Countries, Inequalities – Providers, Project Financing

Interview Protocol

Interview protocol 1. Business as usual 1.1. What are the main sources of external finance for your organisation?

1.1.1. Private – Bonds, private loans. Public – Grants, subsidised loans. Both – Combination

1.2. What are the main type of investors?

1.2.1. Institutional – Pension Funds, Insurance, Private Equity. Private Banks. Public Banks

1.3. How would you characterise your access to funding? Constrained? Easy? Cumbersome? Why?

1.4. What are the leading factors determining your access to finance? Do you expect them to undergo any fundamental changes in the near future?

1.5. In what ways if any has the increase in interest rates challenged your funding strategy?

2. ESG 2.1. Do you currently tap on to ESG for your financing needs?

2.2. Could you reflect on the main reasons for ESG uptake and whether they are likely to change?

2.2.1. Among these factors, which ones are most important?

2.3. There's this term, additionally that shows up in the literature, do you perceive ESG as bringing additional funds into the company?

2.4. Do you use the new European regulation and framework for ESG (CSRD)(Taxonomy)? Is there a set of reporting standards would your organisation is more likely to follow?

2.5. What are the factors that would make you increase the ESG proportion of your funding in the future? If you plan to do so, do you have an explicit strategy to follow?

2.5.1.1. Which among the ESG indicators are your priority?

2.6. Which forms does (or would you like) ESG funding take, do you plan a green bond, an ESG loan from a bank etc.?

2.6.1. What are the likely consequences of these forms of financing?

2.7. ESG is usually linked to specific projects within companies? Within your organisation is ESG used in particular projects?

2.7.1. For example energy retrofit, improving energy efficiency?

2.7.2. Is it about new developments?

3. Financing renovation and energy efficiency requirements 3.1. How is your organisation working through the energy efficiency improvement of the stock? Do you have a number of plans in place?

3.1.1. Funding requirements?

3.2. Do you expect the energy transition to be a driving force toward ESG funding or would business as usual cover the needs of your organisation?

3.2.1. If not large-scale renovation, what would you say are the driving forces behind adopting ESG?

3.3. Do you conceive of ESG funding as a viable alternative to rent increases or progressive withdrawals of public increases in costs of private funding?

4. Risks, challenges and recommendations 4.1. What importance do you attach to your overall rating? How is this affected by ESG and renovation?

4.2. Do you have a designated team collecting non-financial data for ESG purposes?

4.3. Do current standards pose any particular issues for housing associations in general or your company in particular?

4.4. What changes would you like to see in the way ESG legislation is being formulated? What would make your access to ESG capital easier?

I.5 Appendix Chapter 7

TABLE I.9 Research Questions, Interview Protocols, and Codes

Research Questions	Interview Protocols	Codes
How did legislative and socioeconomic developments shape land-driven PPPs for social housing provision in the Spanish and Catalan contexts?	– Private business model – Public business model	– Origin land – Rationale – Public debt – Fiscality
How do current fiscal and social policies influence the financial viability of PPPs for social housing provision at INCASOL?	– Private business model – Public business model – Financial and environmental risks	– Next generation — renovation – Financing — subsidies – Rent & increases – Public competition – Fiscality – Financing risk – Oversight

TABLE I.10 Project Parameters

Parameter	Value
Number of units	300
Total surface	40,603 m^2st
Residential space	28,297 m^2st
Cost per sqm	1,104 €/m^2
VAT	4,030,303 €
Maintenance (every five years)	928,943 €
Management costs	148,075 €/year
Land costs (Year 1–30)	213,572 €/year
Land costs (Year 30–75)	12,746 €/year
Debt proportion	80 %
Interest rate	3.25 %
Commercial space income	69,149 €/year
Rental income	2,549,297 €/year
Parking income	343,063 €/year
Efficiency (arrears & vacancy)	5 %
Total years	75
Construction time	2

I.6 Appendix Chapter 8

INCASOL Evaluation Report

Evaluación de propuestas para el desarrollo de Vivienda Protegida en el Área Residencial Estratégica Montesa Parcelas 5, 8 y 11.

Criterios financieros

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Contenidos

1. Introducción

Este informe tiene como objetivo evaluar las propuestas presentadas para el desarrollo de Vivienda de Protección Oficial (VPO) en las parcelas 5, 8 y 11 del área de Montesa, Esplugues de Llobregat, en régimen de derecho de superficie. El análisis desarrollado operacionaliza los criterios subjetivos de adjudicación descritos en el expediente de comercialización 664/2023, publicado por INCASOL el 15 de diciembre de 2023. En particular, en este informe se abordan los criterios financieros especificados en dicho expediente (Punto 12.B 4) Tabla 1, proponiéndose indicadores cualitativos para la valoración subjetiva de las propuestas.

Tabla 1: Criterios Economico- Financieros 12.B

Criteris	Puntuació màxima
B4.1 Per l'exposició clara, concreta i racional dels conceptes econòmics del Pla (inversions, despeses i ingressos previstos). S'haurà de fer constar el pressupost d'execució material per contracte (PEC) de construcció de l'edifici	
Nivell de detall i versemblança de paràmetres	2
Destinació i càlcul del PEC/ Número d'unitats	1
Sub-Total	**3**
B4.2 Per la coherència i optimització de l'ordenació en el temps dels conceptes econòmics pel millor funcionament de la promoció des de l'òptica de l'usuari dels habitatges.	
Costos i prestacions	2
Anàlisi d'assequibilitat dels habitatges	1
Sub-Total	**3**
B4.3 Per la coherència i versemblança de la relació entre el model de gestió tècnica, social i de manteniment i el model financer general.	
Coherència del model financer respecte al model social, econòmic i tècnic	3
Versemblança i coherència del model financer sota diferents escenaris	1
Sub-Total	**4**
Total	**10**

La metodología de análisis se basa en una comparación detallada de las propuestas entre sí, así como respecto a los mínimos requeridos por la legislación vigente y el pliego de comercialización. Además, se han realizado juicios de valor con la aportación de expertos y se ha tenido en cuenta la literatura y metodologías relevantes en materia de análisis financiero. La evidencia sobre la que se base el análisis incluye comparaciones de ratios financieros, análisis de asequibilidad de las viviendas y un estudio de la sensibilidad de los flujos de caja a variaciones en parámetros clave. Para facilitar la comparación entre las propuestas se han realizado adaptaciones de los parámetros financieros así como incorporado referencias al informe de valoración de las propuestas arquitectónicas y sociales.

Siguiendo la Tabla 1, el primer criterio se centra en el análisis cualitativo de las propuestas financieras. Para ello se ha tenido en cuenta la claridad de los conceptos económicos expuestos así como la presentación del Presupuesto de Ejecución por Contrato (PEC) y el número de viviendas propuesto. La racionalidad del proyecto se ha determinado en dialogo con análisis técnicos del proyecto arquitectónico. El segundo criterio toma como referencia el punto del vista del inquilino y se focaliza en los costes totales, prestaciones y el funcionamiento de la promoción. Para ello se ha dado

especial relevancia a los costes refacturables y de trasteros y garajes. Estos son analizados en su totalidad pero también se presenta un desglose por vivienda y metro cuadrado que permite la comparación de las propuestas. El tercer criterio analiza la coherencia del modelo financiero respecto a las propuestas técnica social y de mantenimiento. Dentro de este criterio, recibe mayor relevancia el análisis cualitativo de las conexiones entre las diferentes secciones de la propuesta. No obstante, también se ha llevado a cabo un análisis cuantitativo de ratios financieros y de simulación de diferentes escenarios. La simulación de diferentes escenarios permite analizar el desempeño de cada proyecto en situaciones de estrés. Para esto, se ha dado un formato común a los modelos de flujos de caja propuestos y se han simulado descensos en la indexación de los alquileres, aumentos de la morosidad e incrementos en los costes de mantenimiento no recuperables. A través de la selección de estas tres variables se busca analizar el impacto de una reducción de ingresos (indexación), un aumento de la deuda incobrable (morosidad/vacante) y el aumento de los costes (mantenimiento no repercutible).

Tabla 2: Criteri 0-5	
5	Excel·lent
4	Més que suficient
3	Suficient
2	Tractament superficial
1	Insuficient
0	No es tracta

El análisis cualitativo de las propuestas resulta en valoraciones entre 0 y 5 siguiendo los criterios presentado en la Tabla 2. Por último, en la conclusión, este informe resume las fortalezas y debilidades de cada propuesta, recogiendo las puntaciones en base 5 y convirtiéndolas a los puntos especificados en la Tabla 1 y en el expediente de comercialización .

2. Sobre B Parte 4 Per la valoració del Pla econòmic i financer

2.1 Per l'exposició clara, concreta i racional dels conceptes econòmics del Pla (inversions, despeses i ingressos previstos). S'haurà de fer constar el pressupost d'execució material per contracte (PEC) de construcció de l'edifici

AVIVA: El plan económico y financiero de AVIVA plantea de manera clara el Presupuesto de Ejecución Material (PEC) especificando superficies, costes unitarios y totales de varios tipos de estructuras. El proyecto propone un número superior de viviendas al estimado que sin embargo resulta verosímil desde el punto de vista arquitectural (ver informe arquitectura) y mejora la viabilidad financiera. Además, se especifican partidas vinculadas directamente al PEC como residuos, impuestos, seguros y contingencias. También se detallan partidas indirectamente vinculadas al PEC como honorarios técnicos, gestión y dirección y supervisión arquitectónica. Se especifica el coste de las licencias municipales y de las partidas derivadas de la gestión corporativa. Se especifica que una vez construidos los edificios estos se traspasaran a una entidad dedicada al arrendamiento de vivienda (EDAV). A esto sigue una periodización que asume la adjudicación en Abril de 2024. La descripción de la fase de explotación es escueta pero ofrece información concreta y clara para entender la propuesta. El estudio de mercado identifica correctamente los precios más elevados existentes en el sector privado y el elevado número de demandantes de vivienda inscritos en el registro de solicitantes. El nivel de detalle es más que suficiente para entender el modelo financiero, no obstante, tanto el modelo financiero como el cálculo de los costes de mantenimiento y refacturables podrían haber sido desarrollados con más profundidad.

Metropolitan: El plan económico y financiero de Metropolitan menciona de manera superficial el cálculo del PEC que se desarrolla de manera escueta en un Excel de acompañamiento. El plan económico propone un número de viviendas inferior al máximo contemplado por el planeamiento pero dentro de los mínimos del pliego de licitación. La propuesta incluye la construcción de zonas comunes privativas que sostienen el modelo de explotación incrementando los ingresos totales. Se presentan de manera escueta pero adecuada diferentes posibilidades de financiación para el proyecto. El plan económico concluye con un resumen de los parámetros presentados en el pliego y su desarrollo en un modelo financiero. El modelo de flujos de caja en el Excel adjunto desarrolla el modelo incorporando de manera clara los parámetros requeridos aunque no ofrece una variable explicita sobre los costes refacturables que solo son incorporados directamente en los ingresos residenciales brutos. Aunque el nivel de detalle financiero suficiente, los conceptos económicos derivados del modelo arquitectural basado zonas comunes privativas no se desarrollan tal y como se hace patente en el informe social 12.1 B3.

Redes: El plan financiero de Redes comienza con una explicación detallada del PEC que se ve reducido por un menor número de plantas bajo rasante que lleva como consecuencia un menor número de plazas de garaje. La propuesta detalla el desglose del PEC así como de los gastos directos e indirectos. En el modelo de explotación se especifican el cálculo de los parámetros con un gran nivel de detalle. Se presenta también un modelo de negocio que detalla el precio superior del sector privado y el número elevado de hogares inscritos en el registro de solicitud de vivienda protegida.

Además se presenta un modelo financiero así como los recursos propios de manera escueta y clara. Se especifica también la constitución en EDAV y la fiscalidad consecuente. También se presenta un análisis de rentabilidad del proyecto. El modelo plantea problemas de verosimilitud acerca de la viabilidad financiera del proyecto si el número de final de metros computables y viviendas fuera menor o las obligaciones de plantas bajo rasante fuese mayor. El plan presenta un elevado nivel de detalle acerca de los gastos e ingresos y de su cálculo así como información detallada sobre el proyecto al nivel de las viviendas. No obstante, la complejidad del Excel presentado hace difícil su interpretación en dialogo con el texto de la propuesta. De este modo, el Excel incorpora nuevos parámetros y propone cálculos de ingresos y costes que no son explicados en detalle en el documento principal y dificultan su comprensión(i.e CPI mensual). Finalmente, el documento de Excel incorpora en la última pestaña una serie de estadísticas descriptivas que ofrecen información útil de una manera resumida.

Tabla 3: Resumen criterio 2.1			
	Aviva	Metropolitan	Redes
Nivell de detall i racionalitat de los paràmetres	El nivel de detalle de los parámetros responde de manera completa a los requerimientos de la propuesta si bien el modelo de flujos de caja y el modelo financiero podrían haber sido desarrollados con más detalle.	El nivel de detalle es adecuado pero el modelo de explotación depende de la construcción de zonas comunes privativas lo que reduce los metros útiles privativos. Esto aumenta el coste del PEC de manera injustificada dado que no se desarrollan planes específicos sobre sus posibles funciones o atribuciones presupuestarias.	El nivel de detalle de los parámetros excede lo requerido y plantea de manera clara y detallada indicadores de viabilidad económica y financiera. No obstante, la complejidad del Excel presentado hace difícil su interpretación en dialogo con el texto de la propuesta (i.e CPI mensual, columnas ocultas).
Puntuación	4	3	4
Destinació del PEC/ Número d'unitats	El número de viviendas es más elevado que el permitido pero respeta las condiciones presentadas en el planeamiento y ofrece garantías de verosimilitud.	La propuesta detalla de manera adecuada el PEC. No obstante, se propone un número inferior de viviendas al máximo que plantea el planeamiento.	El número de viviendas es el más elevado de las tres propuestas. No obstante, la verosimilitud del PEC con respecto a la construcción de menos plantas bajo rasante, un elemento que reduce el PEC, plantea contradicciones con el planeamiento.
Puntuación	5	3	4

2.2 Per la coherència i optimització de l'ordenació en el temps dels conceptes econòmics pel millor funcionament de la promoció des de l'òptica de l'usuari dels habitatges.

AVIVA: La propuesta de Aviva presenta de manera explícita un costo medio por m2util (13,5 eur/m2) que incluye los espacios privativos computables, el trastero garaje y local comercial. Se especifica una media de los precios por m2 computables de vivienda. Los costes refacturables se presentan de manera cumulativa y dependen de un solo parámetro (50% de OPEX y property management). No se incluyen de manera pormenorizada el cálculo de los costes refacturables que se atribuirán a los inquilinos ni como se repartirán.

Tabla 4: Comparación del ratio de Refacturables sobre ingresos potenciales

	Aviva	Mtp	Redes
Gross Rental Income 2029	€ 3.732.886	€ 3.619.114	€ 3.698.694
Recoverable Expenses 2029	€ 456.504	€ 361.911	€ 721.528
Ratio	12,2%	10,0%	19,5%

Metropolitan: En la propuesta de Metropolitan no se detallan los precios medios por vivienda, ni la distribución de costes desde el punto de vista del usuario incluyendo el desglose de los trasteros, garajes y costes refacturables . Aunque la propuesta arquitectónica sí que detalla diferentes tipologías y una proporción de zonas comunes privativas incluidas en los metros computables, el análisis de asequibilidad de los costes totales desde la óptica del usuario no se desarrolla. Si bien los costes refacturables totales son menores a los de las otras dos propuestas, no se especifica su proceso de cálculo pormenorizado. Como en el caso de AVIVA los costes refacturables son un 66,7% del OPEX que a su vez es un 15% de los ingresos residenciales brutos.

Redes: Se presenta un coste medio por m2 útil desde el punto de vista del usuario que incluye trastero, garaje y costes refacturables aunque no el desglose por concepto de manera clara por lo que ha sido reconstruido en la Tabla 5. Los costes refacturables si aparecen reflejados de una manera pormenorizada (OPEX, CAPEX y Property tax) aunque la información a veces es contradictoria. Por ejemplo, la tabla de la página 8 de la propuesta económica financiera identifica el IBI como no repercutible, sin embargo, en la página 17 sí que se incluye en los gastos repercutibles al igual que en el Excel. Además en el documento de Excel se presentan dos cálculos distintos para los refacturables totales y los refacturables que corren a cargo de los residentes. En el segundo cálculo, tras sustraer OPEX y Property Tax del total refacturables repercutidos a los residentes, el documento de Excel introduce un límite del 18% de los ingresos totales al CAPEX refacturable aunque este parámetro no se explica en el texto de la propuesta. En el modelo presentado el porcentaje actual de recuperables repercutido a los residentes es 16,7% de las rentas actuales donde se incluyen 537 unit/year en concepto de CAPEX. En términos globales, el porcentaje de los costes totales que se presenta como recuperable es el 85% del total (refacturable & no refacturable). Aunque ajustados a la legislación, Llei d'arrendaments urbans (LAU), esto hace que los costes refacturables incrementen los costes totales para los inquilinos en comparación con las otras dos propuestas (Tabla 4).

La Tabla 5 compara el número y tipologías de vivienda por proyecto así como analiza la asequibilidad de la vivienda en términos absolutos y por m2. Para construir esta tabla se ha llevado a cabo la indexación de los alquileres del mismo modo para todos los proyectos, al año 2027 CPI 2%. Tomando ejemplos de viviendas de tamaño medio especificadas en las propuestas arquitecturales, se presentan costes medios por tipología de vivienda a la que se añaden costes por garaje y trastero así como costes refacturables. Debido a la dificultad a la hora de comparar las propuestas dado que divergen en su cálculo de los costes así como en las prestaciones de las viviendas, estos indicadores son interpretados de una manera cualitativa y subjetiva en la tabla de resumen de las puntuaciones para esta sección.

Comparació preu habitatges – Any 2027			
	Aviva	**Mtp**	**Redes**
Total			
Sqm2 (utiles)	22130	20320	23493
Número	374	324	402
1D	75	0	127
%	20%	0%	32%
2D	227	192	240
%	61%	59%	60%
3D	72	132	35
%	19%	41%	9%
M2 Garatges i Trasters	10316	9293	NA
Total Garatges i Trasters 2027	€ 680,492	€ 613,011	€ 691,792
Total Refacturables 2027	€ 438,777	€ 340,686	€ 698,976
Refacturable mensual por metro util computable	€ 1.65	€ 1.40	€ 2.48
1D			
m2-utils computables	42.75		44.3
Cost utils computables	€ 470		€ 487
Traster i garatge cost	€ 152		€ 143
Càrregues refacturables	€ 71		€ 110
Total	€ 692		€ 740
Cost m2	€ 16.2		€ 16.7
Cost m2 excloent zones espais complementaris	€ 16.2		€ 16.7

Comparació preu habitatges – Any 2027 Continuación			
2D			
m2-utils computables	59	61	61
Cost utils computables	€ 649	€ 671	€ 671
Traster i garatge cost	€ 152	€ 158	€ 143
Càrregues refacturables	€ 97	€ 101	€ 151
Total	€ 898	€ 929	€ 965
Cost m2	€ 15.2	€ 15.2	€ 15.8
Cost m2 excloent zones espais complementaris	€ 15.2	€ 16.6	€ 15.8
3D			
m2-utils computables	75	74	78
Cost utils computables	€ 825	€ 814	€ 858
Traster i garatge cost	€ 152	€ 158	€ 143
Càrregues refacturables	€ 124	€ 122	€ 193
Total	€ 1,100	€ 1,093	€ 1,194
Cost m2	€ 14.7	€ 14.8	€ 15.3
Cost m2 excloent zones espais complementaris	€ 14.7	€ 15.8	€ 15.3
Mitges totals			
Cost m2	€ 15.4	€ 15.0	€ 15.9
Cost m2 excloent zones espais complementaris	€ 15.4	€ 16.2	€ 15.9

Tabla 6: Resumen Criterio 2.2			
	Aviva	Metropolitan	Redes
Costos por m2 i prestacions	Variada tipología de viviendas que dan respuesta a hogares con diferentes necesidades. Costes por metro cuadrado, una vez añadidos costes extra y de gestión, más bajos de las tres promociones. (Tabla 4 y 5)	Tipología de viviendas limitada (2 y 3 D). La comparación de los costes por metro cuadrado excluyendo los espacios complementarios ofrece los precios por m2 más elevados de las tres propuestas (Tabla 5).	Variada tipología de viviendas que dan respuesta a hogares con diferentes necesidades, si bien la proporción de viviendas de tres dormitorios es inferior a la de las otras propuestas. Además, los costes por metro cuadrado son marginalmente más elevados que los de Aviva. (Tabla 5)
Puntuación	5	3	4
Asequibilidad costes totales	Costes totales por vivienda más bajos en uno y dos dormitorios y ligeramente más elevados en las unidades de tres dormitorios, €7 (Tabla 5). Además, los costes refacturables se encuentran entre los más bajos.	Coste total de las viviendas de dos habitaciones es más elevado (€31) aunque las unidades de tres dormitorios son las más asequibles por un pequeño margen (€7) (Tabla 5). Además, los costes refacturables se encuentran entre los más bajos.	La proporción de coste refacturables sobre los ingresos brutos es marcadamente más elevada que la de las otras propuestas Tabla 4 (19%). Esto resulta en un encarecimiento final considerable en el total mensual en todas las tipologías de vivienda entre €48 y €94 al mes (Tabla 5) en comparación con las otras propuestas.
Puntuación	5	4	3

2.3 Per la coherència i versemblança de la relació entre el model de gestió tècnica, social i de manteniment i el model financer general.

AVIVA: El modelo de flujos de caja se construye entorno a los ingresos realizables derivados de los metros útiles computables y los módulos de VPO de 2024. Se presentan también los gastos operativos, costes corporativos, así como morosidad y se incorporan de manera explícita los gastos de rotación y de desocupación. Sin embargo, el modelo no especifica el pago del principal de la deuda y tan solo describe los 10 primeros años de la explotación. Ciertos ratios financieros si se incorporan, LTV y LTC, sin embargo, no se presentan medidas de rentabilidad del proyecto.

MTP: El modelo de flujos de caja responde de manera adecuada a las necesidades del proyecto y presenta coherencia en la incorporación de morosidad y desocupación. Además la incorporación de un modelo financiero detallado permite el cálculo de ratios financieros de manera simple. Sin embargo, no se detalla una partida presupuestaria específica para los espacios comunes privativos que son un componente esencial de la propuesta. Esto plantea problemas de verosimilitud entre el modelo de gestión técnico, el programa de mantenimiento y el modelo financiero en general, ver informe social 12.1 B3.

Redes: El documento de acompañamiento que desarrolla el modelo financiero es difícil de interpretar con tan solo la información planteada en el texto de la propuesta. No obstante, el modelo sí que incorpora los ratios financieros así como ciertas medidas de rentabilidad de manera explícita. El modelo financiero se construye con parámetros laxos sobre los costes recuperables y la indexación de los alquileres, así como con un número de plantas bajo rasante inferior a lo requerido por planeamiento que podría afectar a los costes de construcción.

Dado que los datos incluidos en las propuestas así como su formato presenta variaciones, la realización de un análisis pormenorizado de ratios comunes resulta complejo. La siguiente tabla busca proveer elementos comparativos para el análisis, si bien los indicadores solamente se pueden interpretar como un complemento al análisis cualitativo y subjetivo de las propuestas. La comparación del ratio de ingresos totales y costes posiciona el proyecto de Redes como el más eficiente seguido del de Aviva y por último lugar Metropolitan. Los niveles de Loan to cost son muy similares en los tres proyectos si bien el de Metropolitan es más bajo. El ratio de deuda respecto a ingresos totales es menor en Metropolitan seguido de cerca por Redes, Aviva queda en último lugar. Debido a las diferencia en el cálculo de Net Operating Income y de los costes financieros del servicio de la deuda la interpretación de Debt Service Coverage Ratio (DSCR) resulta imposible de manera común a través de las tres propuestas. La comparación de net yield, adecuada solo en la propuesta de Mtp y Redes, dado que incluyen el pago del principal, deja a Redes por delante por 0,02. En general, estos ratios apuntan a una mayor eficiencia de los proyectos de Aviva y Redes respecto al de Mtp. Esto se debe principalmente a unos ingresos totales superiores en los proyectos de Aviva y Redes y también a una inversión total menor en particular en este último proyecto.

Tabla 7: Análisis adaptado de ratios financieros

	Cap Rate (Adaptacion)			**Loan-to-value**	**Loan-to-cost**	**Debt-to-ebidta**		
	NOI/Ingresos Totales- Dado que no todas las propuestas incluyen el nivel de detalle necesario para calcular el cap rate. Tomamos los ingresos totales del anho 2029.	Market Value. Dado que estimar el valor de mercado de este tipo de proyectos presenta dificultades tomamos de los costes total de construcción	Ingresos totales 2029 to total costs ratio	Tomados de la propuesta	Tomados de la propuesta	**Debt**	**Ingresos totales anuales**	
Aviva	€ 3.756.776	€ 58.624.495	6,4%	55%	60%	€ 35.174.697	€ 3.756.776	9,4
Mtp	€ 3.566.597	€ 59.402.868	6,0%		50%	€ 29.701.434	€ 3.566.597	8,3
Redes	€ 3.698.163	€ 52.263.751	7,1%		60%	€ 31.358.250	€ 3.698.163	8,5

	DSCR -2029			
	NOI	**Debt Service**		
Aviva	€ 3.756.776	€ 1.706.031	2,20	*No incluye el pago del principal
Mtp	€ 3.566.597	€ 2.684.056	1,33	
Redes	€ 3.698.163	€ 3.598.994	1,03	

	Net Yield-2029			
	Net Profit - Excedente de caja una vez incluidos los costes financieros	**Total Investment Tomado como costes totales**		
Aviva	€ 1250883	€ 58.624.495	0,021	*No incluye el pago del principal
Mtp	€ 702094	€ 59.402.868	0,012	
Redes	€ 737108	€ 52.263.751	0,014	

Para entender con más detalle la resiliencia de las propuestas a cambios en el contexto social y económico se ha realizado un análisis de sensibilidad con simulaciones de Monte Carlo (MC), se adjunta un documento de Excel de apoyo. La simulación MC permiten predecir los resultados de un proceso incierto transformando variables imputadas en probabilísticas. Como resultado se obtiene la probabilidad de un evento incierto como es la viabilidad financiera del proyecto. Este informe se centra en analizar la solidez de la propuesta respecto a cambios en las siguientes variables:

- Indexación de los módulos a CPI: cambios en el contexto macroeconómico que podrían resultar en un incremento de los alquileres y costes o en una reducción de los ingresos. Los alquileres de las tres propuestas se han indexado tomando 10,36 eur/m2 en el año 2024. Se toma 2028 como el año base de ocupación, y asumiendo CPI 2, el módulo base es 11,21 eur/m2. A partir de este año las simulaciones aplican CPI respecto a la table 8.
- Vacantes y morosidad: cambios en la capacidad de pago de los inquilinos y descensos en la ocupación que podrían resultar en una reducción de los ingresos. Este parámetro se simula de manera directa como se refleja en la tabla 8.
- Mantenimiento: incrementos imprevistos en el mantenimiento que aumenten los costes. El mantenimiento extraordinario y ordinario se asumen a un mínimo de 370.000 eur como previsto en el pliego. Este montante se multiplica por un factor como se muestra en la tabla 8. A este se le añaden otros costes que incluyen consumos e impuestos municipales e IBI entre otros y se obtiene el OPEX. Los costes de gestión se calculan como un 5% de los ingresos totales. Los costes refacturables corresponden a la mitad de los costes de gestión y OPEX. Esta formula se ha aplicado a las tres propuestas.

El impacto de estas variaciones se mide dentro de cada proyecto a través de la probabilidad de caer por debajo de un Net Present Value (Valor Actual Neto) positivo asumiendo una tasa de descuento del 6%. Si bien, dado que los proyectos presentados son diferentes entre sí, las comparaciones se limitan al Cashflow unlevered dejando a un lado el modelo de financiación externa. Del mismo modo que en el análisis de ratios, para facilitar la comparación se han realizado diferentes ajustes, por ejemplo la actualización de los alquileres al comienzo del año y la previsión de la ocupación completa a partir del año 2028, con la inversión de los costes totales de construcción en el año 2024 (ver documento adjunto 1 para detalle del análisis). Teniendo en cuenta estos ajustes, al análisis se le aplican las mismas limitaciones que al análisis de ratios y los resultados son interpretados de manera cualitativa.

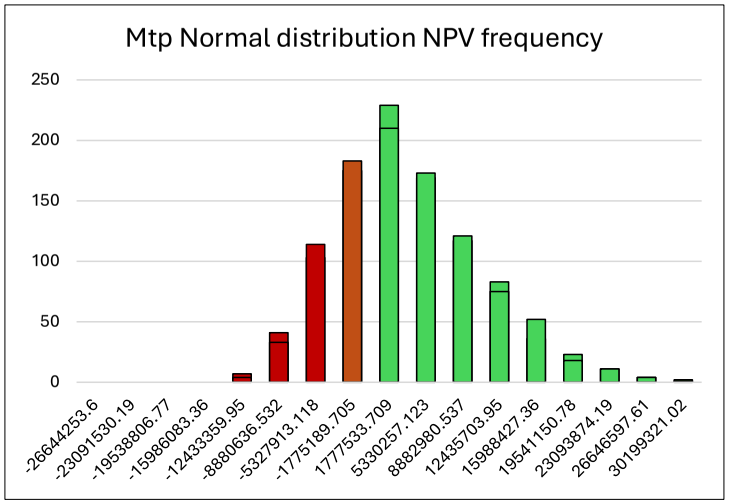
El análisis comparativo de las tres propuestas bajo parámetros similares muestra grandes similitudes entre ellas, por ejemplo, la desviación standard del NPV muy parecida al igual que la TIR media. No obstante, la propuesta de Metropolitan propone unos ingresos muy bajos comparados con los costes de construcción lo que aumenta la posibilidad de un NPV negativo en el caso de

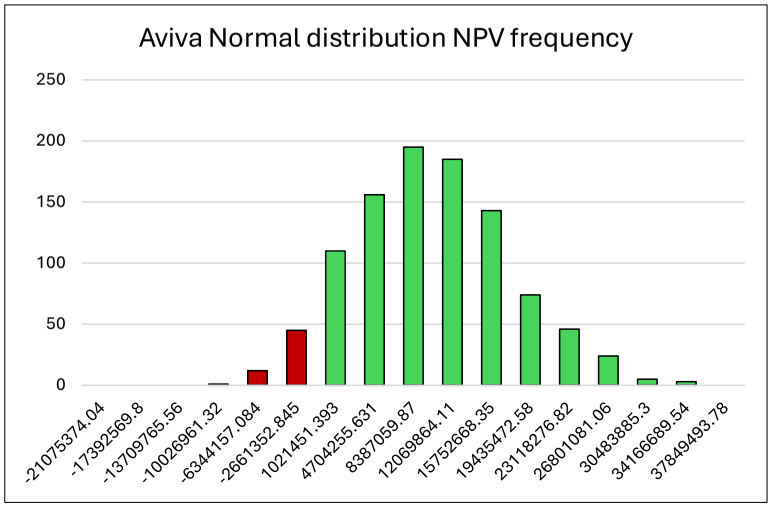
Tabla 8: Momentos de las distribuciones utilizadas para las simulaciones

Variables Modeladas	min	max	media
CPI	0,75	4	2,2
Vacantes	3	10	5
Matenimiento	1	2	1,5

una bajada de los ingresos. De una manera similar la propuesta de Redes se construye bajo parámetros originales más laxos que la propuesta de Aviva y su éxito depende en una mayor manera en la repercusión de costes a los inquilinos y la indexación de los alquileres.

Tabla 9: Impacto de las simulaciones en el Net Present Value						
	min	max	average	st. dev.	prob. Neg NPV	Average IRR
Aviva	-€ 14,118,965	€ 39,911,689	€ 8,144,711	€ 7,585,358	13.1%	6.6%
Metropolitan	-€ 16,707,261	€ 35,637,297	€ 1,903,402	€ 6,986,390	42.5%	6.1%
Redes	-€ 12,411,545	€ 35,692,892	€ 5,605,374	€ 7,017,691	21.2%	6.5%


Mtp Normal distribution NPV frequency
250
200
150
100
50
0
-26644253.6
-23091530.19
-19538806.77
-15986083.36
-12433359.95
-8880636.532
-5327913.118
-1775189.705
1777533.709
5330257.123
8882980.537
12435703.95
15988427.36
19541150.78
23093874.19
26646597.61
30199321.02


Aviva Normal distribution NPV frequency
250
200
150
100
50
0
-21075374.04
-17392569.8
-13709765.56
-10026961.32
-6344157.084
-2661352.845
1021451.393
4704255.631
8387059.87
12069864.11
15752668.35
19435472.58
23118276.82
26801081.06
30483885.3
34166689.54
37849493.78

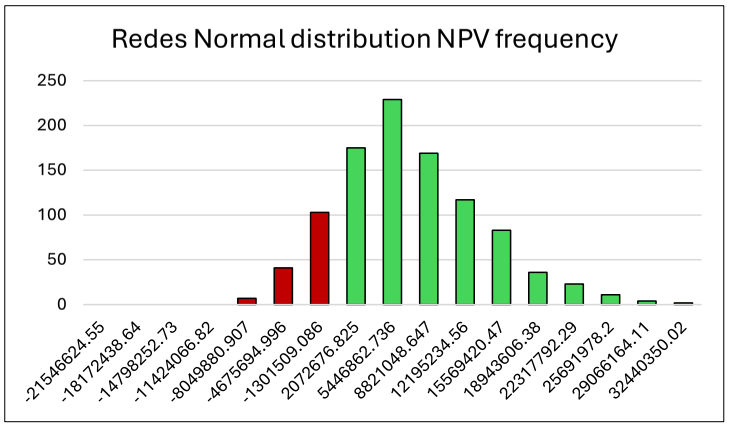

Redes Normal distribution NPV frequency
250
200
150
100
50
0
-21546624.55
-18172438.64
-14798252.73
-11424066.82
-8049880.907
-4675694.996
-1301509.086
2072676.825
5446862.736
8821048.647
12195234.56
15569420.47
18943606.38
22317792.29
25691978.2
29066164.11
32440350.02

Tabla 10: Resumen Criterio 2.3			
	Aviva	Metropolitan	Redes
Informació i coherència del projecte	Se hace patente de manera clara las relaciones entre la propuesta arquitectónica, social y de mantenimiento al mantener los costes repercutidos bajos, cumplir con el mantenimiento y llevar a cabo un modelo de explotación eficiente. No obstante, no se detalle un espacio claro para reunión y de participación en la toma de decisiones de la comunidad.	El plan de explotación no incorpora el uso y mantenimiento de espacios comunes privativos. Este es uno de los elementos sociales clave de la propuesta a nivel financiero que no aparece suficientemente substanciada. Esto impacta la coherencia del proyecto de manera marcada dado que reduce los espacios útiles y el número de viviendas de una manera considerable, lo que tiene un impacto elevado en la viabilidad financiera, sin ofrecer una contrapartida con un valor claro a cambio.	El modelo financiero es coherente y eficiente en sí mismo. Además el mantenimiento se cubre de forma adecuada pero los costes repercutidos son más elevados que en las otras propuestas, lo que aumenta la rentabilidad de la propuesta, pero resta impacto social.
Puntuación	4	3	4
Versemblança i coherencia del model financer sota diferents escenaris	El proyecto presenta un modelo financiero coherente con ratios ajustados a los de las otras propuestas. El modelo está construido con unos parámetros conservadores que hacen que al añadir un análisis probabilístico su rendimiento no decaiga.	El plan financiero es coherente en sí mismo, si bien la utilización de los recursos es menos eficiente que en las otras dos propuestas. El modelo presenta unos costes de construcción elevados en comparación con los ingresos lo que lo hace vulnerable a reducciones de ingresos o aumentos en los costes. Esto explica que el modelo presenta una alta vulnerabilidad a variaciones.	El modelo financiero es coherente y eficiente en sí mismo. No obstante dado que el modelo se ha construido con unos parámetros más laxos que las otras dos propuestas, su rendimiento es menor una vez tomamos los parámetros como probabilísticos.
Puntuación	5	3	4

3. Conclusión y puntuación final

La propuesta de Aviva presenta un PEC detallado y un modelo financiero bien estructurado, con una variedad de tipologías de vivienda y costes totales asequibles. La coherencia del proyecto es elevada, lo que refuerza la viabilidad del proyecto. La incorporación de un análisis de asequibilidad claro desde la óptica del usuario con un Kpi de 13,5 m2 útil computable una vez incorporados trasteros y garajes es un ejemplo claro de verosimilitud entre viabilidad económica, gestión social y proyecto arquitectónico. Aunque el modelo financiero es sólido, podría beneficiarse de un mayor desarrollo en el detalle del flujo de caja y el cálculo de los costes de mantenimiento refacturables.

Metropolitan presenta una propuesta coherente y detallada en términos financieros. No obstante, se propone un número inferior de viviendas al máximo permitido, resultando en un uso ineficiente de recursos. La falta de detalle en los costes refacturables y el análisis de asequibilidad desde la perspectiva del usuario disminuyen la claridad y viabilidad del plan. Por último, dado que las zonas comunes privativas son un elemento central de la propuesta, cabría esperar un nivel detalle mayor sobre su modelo de gestión justificando así su coste para los inquilinos a través de un impacto social positivo.

La propuesta de Redes Proporciona un modelo financiero detallado y coherente con un alto nivel de optimización de recursos. La propuesta incluye un número elevado de viviendas y una especificación de los costes refacturables, si bien esta podría ser más clara. No obstante, la viabilidad arquitectónica y la coherencia con el planeamiento local son cuestionables, debido a las plantas bajo rasante, lo que podría afectar la realización del proyecto tal como se propone. Además, el proyecto presenta una proporción elevada de costes refacturables comparada con los otros dos proyectos lo que pone en cuestión la coherencia del modelo de gestión desde el punto de vista del usuario.

Tabla 11: Resumen Final								
Criteris	Max	Aviva	0-5		Mpt	0-5	Redes	0-5
B4.1 Per l'exposició clara, concreta i racional dels conceptes econòmics del Pla (inversions, despeses i ingressos previstos). S'haurà de fer constar el pressupost d'execució material per contracte (PEC) de construcció de l'edifici								
Nivell de detall i versemblança de paràmetres	2	1.6	4		1.2	3	1.6	4
Destinació i càlcul del PEC (nombre habitatges 341 per planejament)	1	1	5		0.6	3	0.8	4
Sub-Total	**3**	**2.6**			**1.8**		**2.4**	
B4.2 Per la coherència i optimització de l'ordenació en el temps dels conceptes econòmics pel millor funcionament de la promoció des de l'òptica de l'usuari dels habitatges.								
Costos i prestacions	2	2	5		1.2	3	1.6	4
Anàlisi d'assequibilitat dels habitatges	1	1	5		0.8	4	0.6	3
Sub-Total	**3**	**3**			**2**		**2.2**	
B4.3 Per la coherència i versemblança de la relació entre el model de gestió tècnica, social i de manteniment i el model financer general.								
Coherència del model financer respecte al model social, econòmic i tècnic	3	2.4	4		1.8	3	2.4	4
Versemblança i coherència del model financer sota diferents escenaris	1	1	5		0.6	3	0.8	4
Sub-Total	**4**	3.4			2.4		3.2	
Sub Total B4	**10**	**9**			**6.2**		**7.8**	

Alejandro Fernández Pérez

Investigador predoctoral TU Delft

14/10/2024

I.7 CV

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EDUCATION

PhD in Management in the Built Environment **Delft, NL | 06/2021– Present**
Delft University of Technology
- Marie-Curie Fellow | 21 - 2024
- Fulbright Fellow at University of California Los Angeles (UCLA) | 24 - 2025
- Research focus on the decarbonisation of the housing stock, focusing on financing strategies and distributional impacts through a comparative policy perspective.
- Research exchanges:
  - Catalan Land Institute (INCASOL) Barcelona, Spain | 08 – 11/2023
  - Housing Europe Brussels, Belgium | 08 – 11/2022
  - CERANEO Zagreb, Croatia | 01 – 03/2022

Certified Financial Analyst CFA Institute - Passed Level I **05/2024**

MSc in Economics **London, UK | 09/2020– 09/2022**
Birkbeck, University of London
- Quantitative program focusing on empirical economics and policy analysis. *Merit*

MSc in City Design and Social Science **London, UK | 09/2020– 09/2022**
London School of Economics and Political Science (LSE)
- Interdisciplinary program examining cities through the integration of social, political and economic dimensions. *With Distinction.*

BA in Political Science and Public Management **Madrid, Spain | 2012 – 2017**
BA in History **Madrid, Spain | 2012 – 2017**
Universidad Rey Juan Carlos
- Intensive programme covering a wide range of social sciences and Spanish, European and global matters. Cumulative *GPA: 8.98 (10-point scale)*
- Academic exchanges:
  - Universidad Autónoma de Barcelona Barcelona, Spain | 02 – 06/2016
  - State University of New York Oswego (NY), United States | 08 – 12/2015
  - Erasmus Sciences Po Paris Paris, France | 08/2014 – 06/2015

WORK EXPERIENCE

Researcher and Assistant Lecturer **Delft, NL | 06/2021 – Current**
Delft University of Technology
- Building Economics (Academic Years 2022-23 & 2023-24). Prepare teaching materials, short lectures, coached students individually and in small groups.
- Amsterdam Metropolitan Solutions (Academic Year 2022-23). Prepare teaching materials, coached students individually and in small groups.

Research and Public Policy Officer **London | 08/2019 – 06/2021**
Peabody, Registered Social Housing Provider
- Quantitative and qualitative public policy analysis
- Evaluation of internal processes to improve service provision
- External facing research aiming to influence policy makers and raise awareness
- Response to public consultations on new government proposals
- Research briefings for Board and Senior Management Teams

Research and Development Analyst **London | 09/2018 – 09/2018**
Walulel, Urban Tech Start-Up
- Analyses of social and economic datasets using specialised software (QGIS, R)
- Design of composite quantitative indicators using proprietary and publicly available data
- Market research and outreach communications: drafting texts, producing graphs and maps
- Coordination of a group of seven researchers in data gathering activities

Urban Development Researcher **London| 02/2018 – 09/2018**
Walulel, Urban Tech Start-Up
- Analysis of publicly available data related to London, and visually representing it using digital illustration tools (R & QGIS)

Policy Intern **Madrid | 05/2017 – 08/2017**
Spanish Ministry of Public Works, Sub-directorate for Planning Policy
- Evaluation of Urban Sustainable Development Strategies funded by the European Union

Research Assistant to Professor Enrique San Miguel Pérez **Madrid | 12/2016 – 06/2017**
Universidad Rey Juan Carlos (Scholarship awarded by the Spanish Ministry of Education)
- Support of the department in the organisation of event. Archival research and literature revision.

Policy Intern **Madrid | 10/2016 – 01/2017**
Spanish Ministry of Foreign Affairs, Sub-directorate for Eastern Europe and Central Asia
- Draft of analytical reports on political, social and economic developments in related countries
- Monitor activities of OSCE and other European cooperation organisations

PUBLICATIONS (Pre-PhD)

- **"The influence of the European Union in urban policy innovation: the Spanish case"**(Original in Spanish) in *Innovación En Politicas Urbanas.* pp. 97-11 Madrid. 2019. Link.
- **"Socio-economic value at the Elephant & Castle."** London School of Economics and Political Science, Department of Sociology, London, UK. 2018. Link.
- **"Life and Work of Leopoldo Maria Panero: Poetics of the Spanish Transition"** (Original in Spanish) in *Derechos humanos y construcción de memoria cívica : cultura democrática y modelos de protección en América Latina y Europa*. pp. 87-104. Madrid. 2017. **Link**.

SELECTED CONFERENCES

- EU – DG Employment, Social Affairs & Inclusion (2023) "The social dimension of housing" Brussels. Social Situation Monitor (SSM)
- UN – Economic Commission for Europe (2022) "Green finance for sustainable development" held as part of the Committee on Urban Development, Housing and Land Management
- European Network of Housing Research (ENHR) (2022) "Understanding the impact of energy efficiency on the housing costs to income ratio: an Instrumental Variable approach" Barcelona
- 3rd International Conference on Energy Research & Social Science (2022) "Analysing The Financial Impact Of Housing Retrofit Policies On Dutch Homeowners: Comparing User Cost And Cash Flow Approaches"

LANGUAGES

- **Spanish**. Native
- **English**. Advanced (C1). Cambridge Certificate in Advanced English (CAE)
- **French**. Advanced (C1). Diplome Approfondi de Langue Française (DALF)
- **Portuguese**. Intermediate (B2). Courses at Casa do Brasil – Madrid.
- **Dutch**. Beginner (A1). Courses at Academia Holandesa – Madrid
- **Arabic.** Beginner (A1). Courses at Erasmus University. The Netherlands.

I.8 List of Publications

Peer-reviewed Journal Articles

- Fernández, A., Haffner, M. & Elsinga, M. (2025) "When Land is Not Enough; Drawing in Private Capital to Increase Social Rental Housing in Spain." Cities. 159. https://doi.org/10.1016/j.cities.2025.105720
- Fernández, A. (2024). "Investigating the impact of housing price increases on consumption: Heterogeneity by age, tenure and housing quality." Journal of European Real Estate Research, 17(2), 232-262. https://doi.org/10.1108/JERER-11-2023-0043
- Fernández, A., Haffner, M. & Elsinga, M. (2024) "Subsidies or green taxes? Evaluating the distributional effects of housing renovation policies among Dutch households." J Housing and the Built Environ, 39, 1161–1188. https://doi.org/10.1007/s10901-024-10118-5
- Fernández, A., Haffner, M., & Elsinga, M. (2023). "Three contradictions between ESG finance and social housing decarbonisation: a comparison of five European countries." Housing Studies, 40(2), 391–417. https://doi.org/10.1080/02673037.2023.2290516
- Fernandez, A., Bezovan, G. (2023). "The Role of Mortgage Subsidies in the Croatian Economic Growth Strategy: a Political-Economy Approach to the SSK." Critical Housing Analysis, 10(1), 50-65. https://doi.org/10.13060/23362839.2023.10.1.553

Peer-reviewed Conference Papers

- Fernández, A. (2022). "Investigating the role of ESG bonds and loans in financing housing renovation among social housing providers: a comparative approach to six European countries." RE-DWELL Conference Housing co-creation for tomorrow's cities. 10.5281/zenodo.7705326
- Fernández, A., Haffner, M., & Elsinga, M. (2022). "Comparing the financial impact of housing retrofit policies on Dutch homeowners." IOP Conference Series: Earth and Environmental Science, 1085(1), 012044. https://doi.org/10.1088/1755-1315/1085/1/012044

Book Reviews

- Fernández, A. (2025)."Residential Capitalism Rent Extraction and Capitalist Production in Modern Spain (1833–2023): By Javier Moreno Zacarés, 2024, ISBN 9781032079257. pp.250." economic sociology. perspectives and conversations, 1–3.https: //econsoc.mpifg.de/50255/06_BookReviews_Econsoc_26-2_March2025.pdf
- Fernández, A. (2025). “Museo Nacional de la Vivienda (MUNAVI), Ciudad de Mexico: a progressive housing narrative or institutional rebranding?” International Journal of Housing Policy, 25(2), 383–387. https://doi.org/10.1080/03601277.2025.2464302
- Fernandez, A. (2024). "Housing in the United States: The basics: By Katrin Anacker, 2024, ISBN 9781032655710, pp. 180." International Journal of Housing Policy, 1–3. https://doi.org/10.1080/19491247.2024.2394270

Datasets

- Fernandez, A. (2025). "Coded interview data underlying the publication: When land is not enough: Drawing in private investment to increase social rental housing in Spain." https://doi.org/10.4121/a4a29e8f-f18b-4288-9668-78f9e68f2584.v1
- Fernandez, A. (2024). "Coded interview data underlying the publication: Three contradictions between ESG finance and social housing decarbonisation: a comparison of five European countries." doi:10.4121/4d4fe7ae-39f5-4683-9cef-0779716179ed.v1

Policy Documents – Appendix Chapter 8

- Fernandez, A. (2024). "Evaluación de propuestas para el desarrollo de Vivienda Protegida en el Área Residencial Estratégica Montesa Parcelas 5, 8 y 11. Criterios financieros."

Contributions to RE-DWELL Deliverables

Reports

- Fernández, A. (2024). "Aspects of housing policies and their importance for affordability and sustainability" in A transdisciplinary perspective on “Policy and Financing” ed. Gojko Bežovan.
https://www.re-dwell.eu/media/d60b3387f740384a0f8316729d5dc7b6.pdf

Case Studies

- Fernández, A., Haffner, M. (2024). "ESG finance and social housing decarbonisation."
https://www.re-dwell.eu/case-library/esg-finance-and-social-housing-decarbonisation
- Fernández, A., Haffner, M. (2024). "Housing Retrofit Subsidies in the Netherlands."
https://www.re-dwell.eu/case-library/housing-retrofit-subsidies-in-the-netherlands
- Fernández, A., Haffner, M. (2023). "Mortgage subsidisation policies in Croatia."
https://www.re-dwell.eu/case-library/mortgage-subsidisation-policies-in-croatia

Vocabulary Entries

- Fernández, A., Haffner, M. (2024). "Window Guidance."
https://www.re-dwell.eu/concept-definition/42
- Fernández, A. (2024). "Viability."
https://www.re-dwell.eu/concept-definition/101
- Fernández, A., Tzika, Z., Furman, S. (2023). "Housing Retrofit."
https://www.re-dwell.eu/concept-definition/21
- Fernández, A., Haffner, M. (2022). "Housing Policy."
https://www.re-dwell.eu/concept-definition/25
- Fernández, A. (2022). "Green Land Value Tax."
https://www.re-dwell.eu/concept-definition/100
- Fernández, A., Haffner, M. (2021). "Affordability."
https://www.re-dwell.eu/concept-definition/41

25#16

Housing Affordability and Decarbonisation in Europe

Essays on Policies, Costs, and Provision

Alejandro Fernández Pérez

Housing markets have produced structural inequalities evident in the unaffordability issues experienced by many households across Europe. Over the past century, housing has shifted from a domain of strong government intervention to one increasingly influenced by market forces. Today, as Europe decarbonises, not only affordability but also sustainability have become central to housing debates. This dissertation investigates how decarbonisation policies affect both housing affordability and provision. Following an essay-based structure (capita selecta), this thesis brings together studies on fiscal policy, sustainable finance, and social housing provision across various European settings. The dissertation is divided into two main parts. Part I, *Affordability and Costs*, employs quantitative methods to assess the economic impacts of decarbonisation on households. Part II, *Provision and Finance*, takes a qualitative approach to examine financing mechanisms for decarbonisation and social housing provision. While each part draws on distinct methodologies, together they provide an overview of how certain decarbonisation policies interact with housing systems at both household and structural levels. The findings show that current decarbonisation policies often favour wealthier homeowners through subsidies and tax incentives, while having a negative or mixed impact on renters, younger households, and low-income groups. To address these challenges, the thesis advocates for redistributive fiscal reforms—such as energy efficiency-linked property taxes—and stronger public institutions and regulations to guide investment towards equitable and sustainable housing provision. By placing affordability at the centre of decarbonisation policies, this dissertation aims to inform the development of transitional pathways that align both social and environmental goals.

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