Green Mortgages*

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Abstract

Using data on the universe of mortgages *on offer* in the United Kingdom, we study the prevalence and features of green mortgages, used for the financing of energy-efficient properties. We uncover substantial heterogeneity in their financial benefits. Products with preferential rate provide discounts of 9-35 basis points (annual gains of £180-700), while those with upfront cashback have annual equivalent gains of £49-56. The former (latter) are more prevalent in the investor (owner-occupied) segment of the mortgage market. We exploit market features to show that green mortgages with cashback offers are used for customer acquisition. We do not find support for the hypothesis that the benefits of green mortgages are due to lower financing risk.

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JEL Classification: R1, G5, Q4, Q5.

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1 Introduction

Banks play a central role in capital allocation in the economy and are key to financing the transition to a net-zero economy.[1] Among the assets they finance, residential real estate is particularly significant in the context of the transition. The operation of residential buildings is responsible for roughly 22% of the global energy consumption and 17% of the CO_2 emissions (Programme (2020); International Energy Agency (2023)). Therefore, investments in improving energy efficiency and environmental performance of houses can contribute significantly in the transition to a net-zero economy.[2] However, significant barriers persist in financing energy efficiency improvements (Giglio et al., 2021; Berkouwer and Dean, 2022; Lanteri and Rampini, 2023).

In responding to these challenges, banks are increasingly offering products known as "Green mortgages" to incentivize households to purchase energy-efficient properties or retrofit existing ones. In these loans the term 'green' refers to the energy efficiency of the properties being financed. In the United States (US), green mortgages are also commonly known as energy efficient mortgages (EEMs) (Palmer et al., 2012; Bardhan et al., 2014).[3] The loans are now available in many countries around the world in addition to the US and the UK.[4] From a borrowers' perspective, they incentivize or reward owning a more environmentally friendly property. However, the magnitude and nature of the incentives offered by lenders are open questions.

In this paper, we use daily data on the universe of mortgages *on offer* in the UK market over a sixteen month period, from May 2022 to September 2023, to provide answers to these questions. The UK mortgage market operates like a 'mortgage supermarket' (Benetton, 2021). In each day there are many products on offer, by different lenders, and with different characteristics. Over the entire sample, and including green and non-green mortgages, there are approximately 4 million daily product entries corresponding to about 180,000 unique mortgages. The

[1] The net-zero transition will require a massive mobilization of capital: McKinsey (2022) estimate that the net zero transition will require $9.2 trillion per year in investment for energy and land use systems between 2021 and 2050.

[2] Achieving reductions in CO_2 emissions in the residential sector to meet the 2016 Paris Agreement targets would require substantial investments in carbon-reducing retrofits (Buchner et al., 2013; Langevin et al., 2019).

[3] See, for instance, `https://www.energy.gov/energysaver/energy-efficient-mortgages`.

[4] There are cross-country differences, but in general they may be used to: (i) finance the acquisition of properties with an efficiency rating above a given threshold or refinance the existing loans on those properties; and/or (ii) finance energy efficiency improvements.

data includes product-level detailed information on product characteristics, green status, green requirements, financial benefits (incentives), lender identity, and broker commission. Further, the data comprises textual descriptions detailing requirements, characteristics, and incentives, which we use in our analyses, to shed light on the features and incentives associated with the products.

We begin by documenting that green products have been growing in prominence, particularly in the residential segment — from less than 10% of the total at the beginning of the sample period to around 15% at the end. Strikingly, the vast majority of green mortgages offered are based on the current energy rating of the property (97%) instead of future improvements in energy efficiency (3%). Therefore, most green products on offer in the UK market do not directly provide funds to owners to improve their properties. Instead, their effects are likely to work through an increase in demand for greener properties, potentially making them more valuable and acting as compensation for purchasing and owning energy-efficient homes.

Our analysis uncovers significant heterogeneity in the nature of the benefits of green mortgages, which also depend on whether they finance an owner-occupier (residential segment) or a rental property (buy-to-let or landlord segment). Roughly 76% of the green product-day observations in the residential market state upfront cashback as an incentive and around 39% state preferential rate, including those mortgages mentioning both preferential rate and cashback benefits. In the BTL segment, a much larger proportion of products state preferential rate (78%) than cashback (14%) as a benefit on green mortgages.[5]

The prevalence of upfront cashback in the owner-occupied sector and preferential rate in the investor segment may reflect differences in borrowers' financial conditions. The typical household has lower wealth and faces greater borrowing constraints than the typical investor, especially when purchasing a house. More constrained borrowers have a lower discount factor, making them value cash upfront relatively more than a reduced loan interest rate over time.

Next, to estimate the magnitude of the benefits of green mortgages, we exploit the granularity of the data and account for the significant product heterogeneity in the market by comparing green to non-green products with the same contractual features, offered to similar types of borrowers on each day. We define product types as groups of products that share the same interest rate type (fixed or variable), initial interest rate fixation period (typically 2 or 5 years), and maximum loan-to-value (LTV) ratio. Borrower types refer to the categories of

[5]Around 1% (6%) of the mortgages state reduced fees as benefits in the residential (BTL) segment.

borrowers for which the product is available, and include first-time buyers, second-time buyers, remortgagors, and among others. Additionally, we sharpen these comparisons by accounting for lender heterogeneity. Therefore, in our most stringent specification, we estimate differences in contractual features between green and non-green products, using granular product type $\times$ borrower type $\times$ lender $\times$ day fixed effects.

In the residential segment, we find that the initial interest rate on green mortgages offering preferential rate is, on average, 35 basis points lower relative to non-green products. Green products offering cashback are 53% more likely to offer cashback, with an average cashback amount that is approximately £241 higher. The financial advantages are smaller but remain both economically and statistically significant when we compare products *within* lenders. The estimated initial rate discount within lender is 9 basis points on the residential segment, and 11 basis points on the BTL market. In the residential segment, the within-lender likelihood of offering cashback and the corresponding amount are 52% and £211 higher for green products, respectively.

With these estimates in hand, we calculate the financial benefit (in £s) for a typical borrower — mortgage with a fixation period of five years and a loan amount of £200,000 — with a qualifying property when choosing a green mortgage product over a non-green one. We distinguish between green products that offer preferential rates and those that provide cashback benefits. Our calculations suggest that green mortgages with preferential rates offer significant financial benefits over similar non-green products with annual gains of £180-700. In contrast, green products offering upfront cashback provide much smaller financial gains, with annual equivalent gains of £49-56. These results suggest a substantial heterogeneity in the financial benefits provided to borrowers through different incentives on green mortgages.

The estimated financial benefits that lenders offer on green mortgages may reflect lower default risk due to the "cash-flow channel," as energy-efficient homes reduce utility costs, leaving borrowers with more disposable income to service debt. Simultaneously, greener properties may retain higher values or resist "brown discounts" in markets that penalize less sustainable buildings, a mechanism we refer to as the "collateral value channel."[6]

To test for the cash-flow channel, we leverage the UK Chancellor's mini-budget announcement of 23 September 2022. The proposed unfunded tax cuts were received with skepticism

[6] Ortega and Taspinar (2018); Bernstein et al. (2019); Baldauf et al. (2020); Murfin and Spiegel (2020); Giglio et al. (2021); Keys and Mulder (2020) show that climate risk impacts the value of real estate assets. Giglio et al. (2021) provides a literature review on climate finance.

by markets, triggering a sharp and unexpected deterioration in credit conditions, including a significant rise in interest rates.[7] More energy-efficient property owners—who likely face lower energy bills—have a greater capacity to manage the higher debt repayments over the term of the loan. As a consequence, under the cash-flow channel, one would expect an increase in financial advantages of green products relative to comparable non-green products following the interest rate shock. However, if anything, we estimate a decline in the benefits of green products in the three months following the announcement, contradicting the prediction.

To test for the collateral value channel, we examine whether the financial incentives of green mortgages are larger for products with a higher maximum LTV ratio compared to those with lower ratios. Higher LTV loans have higher default risk, and in the event of a default, lenders are concerned with the property's ability to maintain its value as collateral to minimize losses. Under this channel, we would expect green mortgage benefits to increase with higher maximum LTV ratios. However, we find no association between the size of the benefits for green mortgages and the maximum LTV.

Another possibility, which we investigate in the last section of the paper, is that lenders offer green mortgages to attract *new* customers. In a competitive market, these mortgages may serve as a mechanism for lenders to differentiate their products, expand the menu of contracts they offer, and cater to an increasingly large proportion of environmentally-conscientious borrowers. While empirically testing this hypothesis is challenging, we present evidence that indicates that this may be an important determinant of lenders' choice to offer these products, in particular those offering cashback.

We exploit features of the UK mortgage markets, whereby most mortgages have an initial period of discounted rate, at the end of which borrowers tend to refinance. Often, borrowers refinance with their current lender, as switching lenders requires a full property valuation and affordability assessment (Benetton, 2021; Belgibayeva et al., 2024). However, borrowers are much more likely to switch lenders when purchasing a property. Since lenders may offer mortgage products specifically for buyers and/or remortgagors, we can test whether green loans are being used as a tool to attract new business.

Consistent with this hypothesis we find that, on the extensive margin, green mortgages are significantly more (less) likely to be available only to home buyers (remortgagors) in the

[7]For instance, the 2-year swap rate increased from 4.44% the day before to 5.56% the day after the announcement. These effects persisted for several months, raising borrowing costs and increasing debt service requirements for new borrowers.

residential segment. These effects hold even when we include lender fixed effects, and are economically large—green products are 22% more likely to be offered only to home buyers than comparable non-green products. In contrast, remortgagors are 10% less likely to be offered a green mortgage. Importantly, these effects are driven almost exclusively by products offering cashback benefits, which provide considerably smaller financial benefits, in sharp contrast with those with preferential rate. In the BTL segment, where most mortgages offer preferential rate, we find no such differences in availability.

Overall, our evidence suggests that some lenders may use the green label, combined with cashback offers, to attract new business in competitive mortgage markets.

Related Literature. Our study provides the first large-sample characterization of green mortgages *on offer* available to both homeowners and investors. The findings complement the literature on debt contracts aimed at tackling climate change that has focused on firms — such as corporate green bonds (Zerbib, 2019; Tang and Zhang, 2020; Flammer, 2021; Baker et al., 2022), sustainability-linked loans (Kim et al., 2022; Du et al., 2023), and blended financing structures (Flammer et al., 2024). There also is a growing literature on bank lending to firms for climate transition, including Kacperczyk and Peydró (2022); Houston and Shan (2022); Sachdeva et al. (2024); Green and Vallee (2024); Ivanov et al. (2024). Compared to these studies, our focus is on the *menu* of green mortgage contracts offered to households and real estate investors and in our ability to characterize their features and benefits, to shed light on the extent to which these products enable green transition in the real estate sector.

In its focus on mortgages, our paper is more closely related to the recent papers that study how the realization of climate change related natural disasters such as wildfires and hurricanes impact mortgage markets (Issler et al., 2020; Gete and Tsouderou, 2021). In addition, our focus on credit is particularly important since the literature has identified an energy efficiency gap in the residential sector (Allcott and Greenstone, 2012), and the work of Berkouwer and Dean (2022) suggests that credit availability can facilitate the adoption of energy savings technologies.[8] This is behind government interventions in loan provision for energy retrofits (Bellon et al., 2024). In contrast, we study the provision of credit by the private sector and loan features

[8]This contrasts, albeit in a different setting, with the limited success of subsidies (e.g. Fowlie et al. (2018)). At the same time, regulations can trigger energy efficiency investments (Clara et al., 2024). On the other hand (Adelino and Robinson, 2023) study how enhancing credit availability can lead to the purchase of larger houses which consume more energy.

offered by lenders.

Our analysis shows that lenders are increasingly offering products that reward the ownership of green homes, which may make them more valuable and in this way incentivize energy efficiency investments. There is a literature that has studied the motivations of banks to originate green lending (Giannetti et al., 2023; Haushalter et al., 2023).[9] We contribute to this literature by uncovering evidence of significant heterogeneity in the nature and magnitudes of the benefits of green mortgages offered by different banks. Those that offer upfront cashback have much lower benefits and as we show have additional features so as to attract new customers. Such loans will have a negligible impact on the cost of capital, and a muted role in decarbonizing the real estate sector (see Berk and Van Binsbergen (2021); Hartzmark and Shue (2023) in the context of firms).

2 The institutional setting and data

2.1 The energy efficiency of the housing stock

The green label refers to the energy efficiency of the residential property that is being financed, which can be obtained from the Energy Performance Certificate (EPC). In England and Wales, EPCs have been required by law since the 1st of October 2008 to sell or rent out a home.[10] The certificates are valid for ten years but may be updated before expiration.

EPCs for existing homes are generated using a Reduced data Standard Assessment Procedure (RdSAP). An accredited assessor visits the property to gather information on its characteristics (property type, size, insulation, heating system, etc.) and its energy sources. The information is collected in a datasheet and then entered into a government-approved software that generates the EPC.[11] The cost of a certificate ranges between £60-120. For newly built properties, a more comprehensive Standard Assessment Procedure (SAP) is used (see, Clara et al. (2024), for more details).

EPCs provide a measure of the overall energy efficiency rating of the property on a numerical scale of 1 to 100 (SAP points) that reflects its energy running costs. These SAP points ratings

[9] See, De Haas (2024); Morse and Sastry (2024); de Bandt et al. (2023) for recent reviews of the literature.

[10] There are a few exceptions, such as listed homes and residential properties that will be used for less than four months of the year.

[11] The software is based on an engineering model. Measurement is one of the crucial bottlenecks discussed by Bardhan et al. (2014) for energy efficiency retrofits.

are grouped in bands and converted into a letter rating, from A (the most efficient, 92 plus points) to G (the least efficient, 1-20 points). Most green mortgages use the letter ratings to determine product availability, specifically A/B or A/B/C.

Residential buildings in the UK are one of the lowest-ranking in Europe in terms of energy efficiency across various metrics (Fetzer et al., 2023). Table 1 shows the percentage of dwellings with a given energy efficiency rating, by construction year. The data are from the the Energy Housing Survey for 2022. Older properties are significantly less energy efficient than newer ones. For instance, among the pre-1919 properties, 79% have energy efficiency rating of D or lower. The comparable figure for those constructed after 1990 is only 17%.

[Insert Table 1 here]

Further, Table 1 shows that there are relatively few properties with ratings A/B in the housing stock, with most built after 1990 (around 13% of those built after this year). The proportion is significantly larger when one additionally considers properties with a rating of C (83% of those built post-1990). The last four columns show energy use (KWh/m^2/year), cost (£/year in 2012 prices), emissions (tonnes/year) and number of properties (in 000s). Older, less energy efficient houses use significantly more energy, are more expensive to run, and generate a higher level of CO_2 emissions.

2.2 The UK mortgage market

The UK mortgage market has several distinctive features that make it particularly useful for our analysis. The long-term fixed rate mortgage, commonly used in the US, does not exist in the UK. Most products have an initial period of discounted and fixed interest rate (the most common periods are 2- and 5-years), at the end of which the interest rate reverts to a typically much higher variable reversion rate. Most borrowers refinance their loans when this period of discounted rate ends, a process which is much simpler for same lender refinances without equity extraction since it does not require a full property valuation nor an affordability assessment.

There are many different products on offer, by different lenders, and with different characteristics (fixed versus variable rate, fixation term, maximum LTV, borrower type (e.g., first time buyer, remortgagors), initial interest rate, fees, early repayment charges, green or not, among others). Pricing depends (among other) on the LTV the loan. As part of the underwriting, lenders carry out income and credit risk checks and an affordability assessment, for both

loans used to acquire a property and those that involve equity extraction. These assessments determine whether the borrower qualifies for the loan, but conditional on approval, they do not affect loan interest rates.

There are two distinct segments of the mortgage market, depending on whether the loan is for the financing of an owner-occupied or a rental property. The latter is commonly known as the BTL sector. Lenders offer loans specifically for each of the segments. Loans in the owner-occupied sector and those offered to 'accidental landlords' in the BTL sector are regulated by the Financial Conduct Authority (FCA).[12] The remaining BTL loans are regulated by the Prudential Regulation Authority (PRA) of the Bank of England (see, Cocco et al. (2024) for more details).

There are many different lenders in the market, including banks, building societies (mutual organizations) and other lenders (shadow banks). Among banks, it is common to distinguish between the largest lenders (e.g. the Top 7) and the remainder smaller banks. Lenders have a differential presence in the owner-occupied and rental segments of the mortgage market. The different lender types tend to be present in both segments, but small banks, building societies and shadow banks tend to have a more significant presence in the BTL sector.

2.3 Data sources

Our main data source is Moneyfacts Group plc, an independent data provider that collects information on the products *on offer* in the UK retail financial industry, including mortgages, insurance, credit cards, retirement products, etc. The data are widely used by consumers, lenders and regulators. It has previously been used in academic research (e.g., Coen et al. (2023); Benetton et al. (2024)). It is important to emphasize that the data covers the loans *on offer* on each day, i.e., the menu of contracts from which borrowers can choose, and not the loan originations.[13]

We use daily mortgage data from May 27, 2022 to September 30, 2023. The starting date is the day in which the green information (the green status and associated qualifying criteria and benefits) was added to the data. It provides comprehensive information on mortgages

[12] Accidental landlords are those individuals who became landlords by 'accident.' They or a member of their family have previously lived in the rental property.

[13] For residential mortgages, origination information is available in the Product Sales Data, an administrative dataset collected by the the Financial Conduct Authority. The origination data does not contain a green loan identifier.

available in the UK market, namely daily product-level information on: (i) market segment (residential or buy-to-let); (ii) product characteristics such as maximum loan-to-value, interest rate, fees, mortgage type (fixed or variable rate, interest rate fixation period), green status, green requirements, financial benefits (incentives), early repayment charges, and whether it's a new build; (iii) lender identity, sales channel (direct or brokered), and broker commission.

The data comprises various numerical variables along with textual descriptions detailing product requirements, characteristics, and incentives. Appendix B includes variable definitions and describes the process of extracting numerical information from these descriptions.

Over the sample period, there are approximately 4 million daily product entries corresponding to about 180,000 unique mortgages (including green and non-green products), with nearly 125,000 (70%) of these offered to the residential segment. A product is defined as a unique combination of all mortgage characteristics recorded by the data provider, including those previously described, as well as additional attributes such as the borrower types for which the product is available. Whenever any characteristic of an existing product changes, Moneyfacts records it as a new product, with a unique identifier.

Figures 1a and 1b plot the daily count of the number of products on offer in the residential and BTL segments, respectively, distinguishing between green and non-green products. As expected, green products are fewer in number, but represent an increasing share of the total —rising from less than 10% at the start of the sample period to around 15% by the end in the residential sector. In contrast, the share of green products in the BTL segment remained more stable, averaging around 11%.

[Insert Figure 1 here]

Figure 2a plots the daily proportion of lenders offering green mortgages across both the residential and BTL segments. On average, around 22% (19%) of lenders offer green products in the residential (BTL) segment. In the residential market, this proportion varied between 18% and 25%, whereas the BTL segment shows greater time-series variation, ranging from 14% to nearly 25%.[14]

[14]In the figure we use the lender identifier provided by the data provider. Some of these lenders are part of a larger banking group. Therefore, as a robustness, Appendix Figure A1 replicates this analysis using the consolidated lender classification. When considering ultimate owner companies, the time series fluctuations are quite similar, but the average level of offering of green products is roughly 2 percentage points higher in both segments.

[Insert Figure 2 here]

Figures 2b and 2c break down the overall shares by lender category. In the residential segment, on average approximately half of top 7 lenders offer green mortgages during our sample period. The remaining three categories have significantly smaller shares, each not exceeding 30%. In the BTL segment, shadow banks have a notable share of green products, surpassing the average share of the top 7 lenders, followed by other banks and building societies (mutual organizations).[15]

2.4 Summary statistics

Table 2 presents information on *unique* green products in our sample, focusing on the energy efficiency requirements of the underlying property, extracted from green product descriptions. Strikingly, the vast majority of mortgages are based on the current energy rating of the property (97%) instead of future improvements (3%). In terms of the EPC rating, roughly 64% of the green products are for properties rated A/B and 33% for properties rated A/B/C.

[Insert Table 2 here]

Table 3 presents summary statistics for the main product characteristics, comparing green with non-green products. The unit of analysis is product-day, so that products that are offered for longer periods will have more observations and a higher weight in the summary statistics.

In the residential market (Panel A), most product characteristics do not show substantial differences between green and non-green products. However, green products are less frequently available for remortgages (36% of the product-day observations for green products compared to 60% for non-green) and are much more likely to offer cashback (73% compared to 29%). The *Cashback (binary)* variable is available for all products (green and non-green), and it is originally provided by the data provider. The average cashback amount also differs, with green products offering on average around £334 compared to £122 for non-green products.[16] The

[15] Also shown in these figures is a vertical line marking the mini-budget announcement of 23 September 2022, an event within the sample period that we use to identify the mechanisms. We provide a more detailed explanation of this event in Section 2.5.

[16] In Appendix Figure A2, we confirm that the difference in the probability of cashback between green and non-green products is persistent over time. For the cashback amount, we observe a gradual decline in the average amount offered by green products, particularly in the residential market, while the average amount for non-green products shows little variation over time.

average initial interest rate on green products is 5.26% compared to 5.51% for non-green ones, while the fees are also on average lower for the former.

The variables in the bottom three rows of Panel A capture what the lenders state as financial benefits of their green products. These variables are extracted from the green description of the product, as detailed in Appendix B. Therefore, they are only available for green mortgages. Most green products state cashback as financial benefit (0.76) but the proportion of those offering a preferential rate is also significant (0.39). These fractions add to a value of more than one since some mortgages state both preferential rate and cashback as financial benefits. A very small proportion of loans state reduced fees as benefits. The table also shows that there is a small discrepancy between the proportion of green products that offer cashback according to their stated benefits (0.76) and that recorded in the cashback variable (0.73).

[Insert Table 3 here]

Panel B presents statistics for the BTL segment. There are significant differences in some of the patterns compared to the owner-occupied sector. A much larger proportion of the green mortgages state preferential rate (0.78) than cashback (0.14) as a benefit. The average amount of cashback is also significantly lower, even though as before it is higher for green than non-green loans. Another important difference is that for investor loans, the proportion of mortgages that are available to remortgagors is similar between green (0.80) and non-green (0.81) products.

Further, Appendix Table A1 shows summary statistics by energy efficiency requirement of the properties being offered green mortgages. We distinguish between mortgages available only for A and B rated properties and those available for A, B, and C rated properties. In the owner-occupied sector, products targeting properties with an A or B rating are much less frequently available to remortgagors (0.24 compared to 0.64) and are much more likely to offer cashback (0.90 versus 0.30). In contrast, in the investor market, a much larger number of mortgages target properties with a rating of A, B, or C and offer a preferential rate but not cashback. These results are relevant, as regulations target energy inefficiencies that are larger in the rental sector than in the owner-occupied sector (see, Clara et al. (2024)).

Lastly, Table 4 presents product characteristics split by lender category. In the residential segment, the proportion of green product-day observations varies significantly across lender types: approximately 21% among the top 7 lenders, 12% among other smaller banks, less than 1% for building societies (other than Nationwide which is among the top 7 lenders), and 7%

for other non-bank lenders (shadow banks).[17]

[Insert Table 4 here]

From the table it is evident that green product characteristics differ across lender types, with the top 7 lenders offering products that generally have longer fixation periods, are less frequently available for remortgagors, and have a higher likelihood of offering cashback. Among these lenders, cashback is the most commonly stated financial benefit of green mortgages, while other lender types primarily emphasize preferential rates. In the BTL segment, shown in Panel B of Table 4, the proportion of green observations is around 12% for both top 7 lenders and banks, less than 0.1% for building societies and 15% for other lenders. Most product features show smaller variation across lender types in this segment. Preferential rates are the most commonly stated financial benefit across all lender types.

2.5 Mini-budget Announcement

During our sample period there was an event that we exploit for identification, namely the mini-budget announcement of 23 September 2022. On this day, the UK chancellor unexpectedly announced large unfunded tax cuts, which were received with skepticism by markets. The announcement triggered large increases in swap rates, used by lenders for the pricing of mortgages. The mortgage market effects were significant, with a sharp decrease in the number of products on offer (Figures 1a and 1b) and a rise in the average interest rates (Figure 3). The event was widely discussed in the news and very salient for borrowers.

[Insert Figure 3 here]

Figure 3 shows that prior to the mini-budget announcement interest rates were already increasing as a result of monetary policy tightening. But the event triggered a large unexpected interest rate shock. The figure also shows that offered interest rates are on average higher in

[17]The top 7 UK lenders, as measured by the value of mortgages outstanding in 2023, are Lloyds Banking Group, Nationwide Building Society, Natwest Group, Santander UK, Barclays, HSBC, Virgin Money. After the end of our sample period Virgin Money was acquired by Nationwide, with the acquisition completed on October 1, 2024. Among the top 7 lenders, and during our sample period, Santander UK and HSBC did not offer green mortgages. HSBC introduced the Energy Efficient Home Cashback mortgage on March/27/2024. Santander UK launched green mortgages on September/24/2024.

the BTL than the residential sector, and that within each sector, they tend to be higher for not green than for green products. These are, of course, simple averages without any controls.

We also confirm the significant impact on the interest rates using aggregated data from the Bank of England. Appendix Figure A3 shows large increases in the initial interest rates for the typical mortgage contracts (2-year fixed mortgages, for loans with 75% LTV ratio). Both inflation and the house price index reversed their upward trends following the event.

3 Nature and magnitude of the financial benefits

3.1 Nature of the financial benefits

Most of the mortgages are offered to finance properties that currently have a given level of energy efficiency and not for improvements to an existing property. This means that most loans do not directly provide funds to owners and investors to improve properties. Their effects will work through the demand for green properties —compensation for purchasing and owning energy efficient homes —potentially making them more valuable.

The summary statistics showed significant differences in targeted properties and financial benefits across the owner-occupied and investor segments of the market. The same patterns hold when the unit of observation is unique products. Figure 4a shows that, in the owner-occupied segment, the vast majority of products for properties with an A or B rating provide cashback to borrowers (around 88%). For products offered to properties with an A, B, or C rating, the most commonly stated benefit is a preferential rate, with more than twice as many products offering this benefit compared to cashback. A smaller, residual category of products offers reduced fees.

[Insert Figure 7 here]

In the investor market (Figure 4b), in stark contrast to the owner-occupied segment, loans offering preferential rate are much more common, as are those targeting properties with an A, B or C rating. In this market segment, there are few unique products (446 in total) offering cashback. The prevalence of cashback in the owner-occupied sector and preferential rate in the investor sector may be due to the differential situation of borrowers. The typical household has lower wealth and is more borrowing constrained than the typical investor, more so for those

households purchasing a house. More constrained borrowers have a lower discount factor and, as a result, value upfront cash relatively more than lower loan interest rate over time.

One potential explanation is that lenders may specialize in offering green products to properties with specific energy-efficiency ratings. When considering the original lender classification provided by Moneyfacts, no lender provides green products for both property categories—those rated A/B and those rated A/B/C. Among lenders offering green products within these categories, 55% focus exclusively on properties rated A/B, while 45% target properties rated A/B/C. Alternatively, when considering the consolidated lender classification by financial group, the share of lenders offering products for both A/B only and A/B/C is relatively small, on average around 7%.

Further, the data suggests that there is segmentation of incentives across the two segments —lenders tend to adopt a single type of financial benefit for their green products. Out of the 36 lenders offering green products according to the original classification from Moneyfacts, only 7 state both preferred rates and cashback as incentives, while just 1 offers both preferred rates and reduced fees. The remaining 28 lenders apply a single financial benefit across all their green products.

Therefore, there are significant differences across segments and lenders in the nature of the green products on offer, that we consider when estimating the magnitude of the financial benefits of green loans.

3.2 Magnitude of the financial benefits

In the estimation of the financial benefits, and for the remainder of the analysis, we focus on the largest categories of loans on offer in the market. Specifically, we estimate the benefits of green mortgages in terms of initial interest rate for both the residential and BTL markets. For cashback incentives, we focus on the residential segment only.[18]

[18] As Figure 7 shows, the remainder are significantly less common and we do not have enough observations for the estimation. Initial product fees can typically be added to the outstanding loan balance so that they are different from cashback.

3.2.1 Empirical specification

To estimate the magnitude of the financial incentive associated with green mortgages, we estimate the following model:

$$y_{ijblt} = \alpha + \beta \cdot \text{Green}_i + \lambda_{jblt} + \epsilon_{ijblt}, \tag{1}$$

where i and t are product and day indexes, respectively. The subscripts j, b and l refer to product characteristics, borrower types, and the lender providing the product.

As outcome variables y_{ijblt}, we focus on the initial interest rate, probability of cashback, and cashback amount. Among the explanatory variables, Green_i is an indicator variable that takes the value of one if the product corresponds to a green mortgage and zero otherwise. The λ_{jblt} corresponds to product type (j) $\times$ borrower type (b) $\times$ lender (l) $\times$ day (t) fixed effects. Product types are defined as groups of products that share the same interest rate type (fixed or variable), the same initial interest rate fixation period (typically 2 or 5 years), and the same maximum loan-to-value ratio. Borrower types refer to the categories of borrowers for which the product is available, including first-time buyers, second-time buyers, remortgagors and others. Products may be available to any combination of these four borrower types.

By saturating the model with fixed effects, the coefficient β, compares incentives using daily variation across green and non-green products of the same type, offered to similar borrowers, on the same day, by the same lender. We cluster standard errors by lender, allowing errors to be correlated within products and over time within lender (Roberts and Whited, 2013; Abadie et al., 2023).

3.2.2 Results

Panel A of Table 5 shows the results of estimating Equation (1) for the initial rate as dependent variable, incrementally adding fixed effects. In this panel, we consider all green products available in the market on each day. The initial rate is one of the primary factors borrowers consider when selecting mortgage products and is also a frequently highlighted benefit of green mortgages. Columns (1) to (3) refer to the residential market, and columns (4) to (6) to the BTL segment, which are estimated separately.

[Insert Table 5 here]

In column (1), where we include only product type × day fixed effects, the estimated coefficient is -0.39. This means that within the same product type on the same day, green products offer an initial rate that is, on average, 39 basis points lower than non-green products. In column (2), we additionally include an interaction with borrower type to ensure that we compare products offered to the same pool of potential borrowers. Under this specification, the average discount lowers to 24 basis points. In column (3), we add the interaction with lender fixed effects, which significantly increases the explanatory power of the empirical model, as noted by the increase in the Adjusted-R^2. When conditioning on similar products offered on a given day to the same pool of potential borrowers by the *same* lender, we document a considerably smaller discount on green products, of approximately 4 basis points. All estimated coefficients are statistically significant at least at the 10% level.

The decrease in the magnitude of the estimated coefficient from column (2) to column (3) indicates that, after accounting for the relevant product characteristics included as fixed effects in our specifications, the within-lender average discount for green mortgages is considerably smaller than the market-wide average discount observed for these products. Some lenders may specialize in offering only green or non-green products within each product type × borrower type × day group. These observations are used for estimation in column (2) but drop out when estimating *within* lender in column (3). This effectively changes the set of observations used to estimate the discount on green mortgages. However, we note that the difference in the number of observations between these columns indicates that only around 6% of the observations considered in column (2) correspond to singletons when including also lender fixed effects. Thus, the vast majority of the lenders offer both green and non-green products within each product type × borrower type × day group.

In the BTL market, we observe a similar decrease in estimated benefits as we saturate the model with fixed effects, with estimates ranging from -18 to -5 basis points, but not statistically different from zero. We return to the question of why lenders offer different incentives across market segments in Section 4.

Note that our empirical specifications include all green products in the market and may therefore underestimate the financial benefits of products that emphasize these advantages more explicitly. To assess the extent of the underestimation, we re-estimate the initial rate discount for green products that explicitly state "preferential rate" as a benefit, compared to all non-green products. Panel B of Table 5 reports the results. In the residential market, the

estimates are generally larger than those in Panel A, with green products offering a statistically significant reduction of 35 basis points *across lenders* and 9 basis points *within lender*. In the BTL market, when controlling for lender fixed effects, the estimated discount (11 basis points) closely aligns with that observed in the residential market.

Another commonly stated benefit of green mortgages in the owner-occupied sector is cashback, which we analyze in Table 6. Panel A considers all green products. In columns (1) to (3), we estimate a linear probability model where the outcome is an indicator variable equal to one if the product offers cashback and zero otherwise. In columns (1) and (2), we find that green products are 34–42% more likely to offer cashback than comparable non-green products. When including lender fixed effects in column (3), the estimated coefficient remains similar at 39% and statistically significant at the 5% confidence level.

[Insert Table 6 here]

In columns (3) to (6), we consider the cashback amount offered by each mortgage product.[19] It is set to zero for mortgages without cashback and to the corresponding pound amount for those offering it. As a result, it captures a combination of extensive and intensive margins of cashback. Green products offer, on average, £158-206 higher cashback than comparable non-green products in the market (columns (4) and (5)). When controlling for lender fixed effects (column (6)), the estimated coefficient is £145, which is both economically and statistically significant.[20] In Appendix Table A3, we repeat this analysis for the buy-to-let segment. We find no statistically significant difference in either the likelihood of cashback or the corresponding amount between green and comparable non-green products.

In Panel B of Table 6, we focus on green products that state "cashback" as a benefit. The estimates for the probability of cashback are larger than before, ranging between 0.62 and 0.52. A similar conclusion holds for the cashback amount, ranging from £295 to £211 higher. Overall, conditioning on products that state specific financial benefits increases the economic magnitudes of our estimates.

[19] In Appendix Figure A4, we compare the distribution of cashback amount across green and non-green products. We find that both across and within lenders there is substantial variation in the amount offered, with the variation being larger for non-green products than for green mortgages.

[20] Appendix Table A2 replicates columns (3) to (6) of Panel A of Table 6 conditioning only on products that offer positive cashback. We do not document any statistically significant difference in cashback amount between green and non-green products, indicating that the results in Table 6 are mainly driven by the extensive margin of cashback.

Lender heterogeneity. Our evidence so far suggests a significant degree of lender heterogeneity in the offering of green mortgages and associated benefits.

As previously discussed, the UK mortgage market is segmented into different lender categories, including the top 7 lenders (which typically have a high-street presence), smaller banks, building societies, and other lenders. In this section, we show that there is still considerable lender heterogeneity in the incentives provided on mortgages within each lender category. To document this, we replicate the estimates from Panel A of Tables 5 and 6, adding an additional specification that includes Product × Borrower × Day × Lender Category fixed effects. In Table 7, we present the Adjusted-R^2 values of our baseline regression models and compare them with those from the new specification.

[Insert Table 7 here]

Including lender category fixed effects increases the explanatory power of our model compared to the specification with only Product × Borrower × Day fixed effects. However, a substantial portion of the variation is only accounted for when we instead include lender fixed effects. For example, when the outcome variable is the initial rate in the residential segment, the inclusion of lender category fixed effects increases the Adjusted-R^2 from 65% to 83%. Instead, including lender fixed effects further increases the Adjusted-R^2 to 95%. This effect is even more pronounced when examining the probability of receiving cashback or the corresponding cashback amount, where the Adjusted-R^2 with lender fixed effects increases by up to 26 percentage points relative to to the specification with lender category fixed effects. A similar pattern holds in the BTL segment. These findings provide strong evidence of significant lender heterogeneity, even within lender categories, particularly in the cashback incentives offered on mortgage products.

3.2.3 Robustness

We consider robustness to assess the stability of estimates to empirical choices. For example, in our baseline specification, we consider lenders as classified by the data provider. However, bank holding companies or financial groups may segment their mortgage products offerings across different subsidiaries. Therefore, we test the sensitivity of the estimate by focusing on ultimate ownership and comparing products offered by the same financial group, even when marketed under different names. Specifically, in our empirical specifications, we replace lender

fixed effects with financial group fixed effects, and as before, to be conservative, we cluster the standard errors by financial group instead of lenders.

In Appendix Tables A4 and A5, we re-estimate Panel B of Tables 5 and 6, respectively, using the consolidated lender classification based on the ultimate ownership of brands or subsidiaries as originally reported by Moneyfacts (details in Appendix B). The overall conclusions of the analysis remain unchanged.

Additionally, as previously discussed, the UK lending market comprises various types of lenders, including the top 7 lenders, which typically have a high-street presence, and others. Some borrowers may consider loans exclusively from these top lenders, which are the focus of Coen et al. (2023). In Table 8 we report results when we restrict the sample to contracts offered only by these lenders. We focus on green products stating "preferential rate" for the initial rate discount and "cashback" for cashback-related outcomes (as in Panel B of Tables 5 and 6).

[Insert Table 8 here]

Both across lenders and within lenders, we estimate a similar initial rate discount of approximately 20 basis points (columns (2) and (3)), with the within-lender discount being twice our baseline estimate. In the BTL market, the across-lender estimates are now statistically significant, ranging from 17 to 19 basis points, while the within-lender discount remains in line with the baseline estimate (10 basis points). For cashback, when restricting the sample to the top 7 lenders, both the likelihood of green products offering cashback and the corresponding cashback amounts remain consistent with our baseline estimates in Panel B of Table 6.

3.2.4 Other contractual features

We next consider two additional relevant product characteristics: (i) product fees; (ii) reversion rate. These, and in particular fees, may be a factor that borrowers take into consideration when deciding on their mortgage products, and therefore could be used by lenders as incentives to green mortgages (although not frequently stated).

Product fees. Appendix Table A6 shows the results for total flat fees (Panel A) and total percentage fees (Panel B). For flat fees, we do not find any statistically significant average differences between green and non-green products. For percentage fees, we estimate a 1 basis point lower fee for green compared to non-green mortgages in the residential market. However,

the within-lender analysis indicates no reduced fees for these products. In the buy-to-let market, we find no statistically significant differences in the estimated coefficients.

Reversion rate. Appendix Table A7 shows the results for reversion rates. We do not find any statistically significant effects in the residential market, and only a negligible effect of approximately 2 basis points lower reversion rates for the buy-to-let market in our most comprehensive specification. These results show that there are no economically meaningful differences in fees and reversion rate between and non-green products.

On average, green products on the market do not have higher fees or reversion rates compared to similar non-green products. However, these patterns may vary depending on the incentives associated with these products. To explore this further, we examine the interaction between incentives on green mortgages and their contractual features. This analysis provides allows us to assess whether lenders who offer specific incentives — preferential rates or cashback — adjust other contractual terms to offset these benefits.

To do so, we estimate the model in equation 1, but we split the variable Green in three categories: (i) green products offering preferential rate only; (ii) green products cashback only; (iii) green products offering both incentives. We present the results in Table 9, focusing on the residential segment. We focus on within lender variation.

[Insert Table 9 here]

First, we confirm that the initial rate discount is concentrated among products that explicitly state preferential rate as a financial benefit (column 1), and the same applies to cashback incentives (columns 2 and 3). However, lenders offering preferential rate *only* tend to offset part of this benefit by charging higher fees, which are, on average, £116 higher (column 4). Although the difference in reversion rates for green products offering a preferential rate is statistically significant, the difference is economically negligible (column 5). Finally, for green products that offer both benefits, we do not find any financial advantage compared to similar non-green products.

Overall, we conclude that green mortgages generally provide lower initial rates and higher cashback compared to similar non-green products on the market. In Section 4, we investigate the potential explanations of why lenders may offer green mortgages, which sheds light on these patterns.

3.3 Back-of-the-envelope calculations

We use our estimates to calculate the financial benefit (in £s), for a typical borrower with a qualifying property when choosing a green product over a non-green one, distinguishing between green products that offer preferential rates and those that provide cashback benefits. When performing these calculations, it is important to note that cashback benefits are received as a lump sum at loan origination, whereas preferential rate benefits are realized through a lower initial interest rate over the introductory period of the loan. Therefore, to compare these benefits, we need to either convert the cashback into an annual equivalent value or determine the net present value (NPV) of the preferential rate savings.

We use the loan's interest rate as the discount rate. Since most UK borrowers refinance at the end of the introductory period, our calculations focus on this time frame, typically either two or five years. We consider two potential scenarios: (i) when the borrower considers the market as a whole and compares products *across* multiple lenders; and (ii) when the borrower evaluates offers exclusively from a single lender.

For residential loans with preferential rates, the estimated benefits correspond to the values in columns (2) and (3) of Panel B of Table 5, amounting to 35 and 9 basis points, respectively. Given that the average mortgage loan amount in the UK is approximately £200,000, the resulting annual benefits are £700 and £180, respectively.[21] For a loan with an initial fixation period of five years, we calculate the NPV of these annual gains using the average 5.26% interest rate of green mortgage products. This yields NPVs of £3,009 and £774, respectively. These figures are significantly higher than those for cashback loans, which are estimated at £241 and £211, as shown in columns (5) and (6) of Panel B of Table 6. Alternatively, one can convert the upfront cashback into annual equivalent figures of £56 and £49, respectively.[22]

We perform similar calculations while restricting the sample to loans offered by the top 7 lenders, using the estimates in Table 8. For residential mortgage loans, the estimated green discounts are 21 and 20 basis points, depending on whether we consider across-lender variation or within-lender variation, respectively. Using a discount rate of 5% (first column of Panel A of Table 4), the corresponding NPVs are £1,818 and £1,732, respectively. The corresponding cashback estimates are, once gain, significantly smaller, ranging between £187 and £215

[21] See, Average mortgage values in the UK.

[22] Note that the conclusion that the benefits of preferential rate are higher holds even under a conservative approach that accounts for the fact that products explicitly stating preferential rate *only* charge, on average, £116 more in fees or only £27 annually, as discussed in the previous section (Table 9).

(columns (5) and (6 of Panel B of Table 8).

Thus, green mortgage products with preferential rates provide significant financial benefits compared to comparable non-green products, both across the market and within the same lender. Green products with cashback offer significantly smaller financial gains.

4 Default risk

The previous section estimated the benefits of green mortgages. A potential explanation of why lenders offer these benefits is that green mortgages carry a lower default risk compared to non-green mortgages. More energy efficient properties are less expensive to run due to decreased energy bills, meaning borrowers have more cash-flow available to service their debt. We refer to this as the cash-flow channel. Additionally, greener buildings are thought to have an increased value — known as "green premium," compared to an equivalent non-green property — or be more resilient to any "brown discount" in markets where less green properties are becoming increasingly unattractive.[23] We refer to this as the collateral value channel.

All else equal, borrowers seeking mortgages for green properties may have lower default risk due to both the cash-flow and collateral value channels, which are reflected in the benefits provided. Unfortunately, the loan origination data from the Bank of England or other regulatory data do not have information on which products are green, making it difficult to compare the two in terms of default outcomes. However, we make progress by exploiting the mini-budget announcement detailed in Section 2.5.

4.1 Cash-flow channel

The mini-budget announcement led to substantial increases in mortgage rates and debt service requirements for new borrowers. Green property owners, facing lower energy bills, may have greater capacity to manage the higher debt repayments. As a consequence, under this channel, one would expect an increase in the financial advantages of green products relative to comparable non-green products following the mini-budget announcement. The unexpected nature of the event and the high-frequency of the data help for identification.

[23]There is a large literature documenting that, globally, buyers and sellers pay attention to energy efficiency of their homes (see, Eichholtz et al. (2010); Myers et al. (2022); Lu and Spaenjers (2023); Sejas-Portillo et al. (2025) and cites therein).

We formally test this hypothesis by narrowing our analysis to a three-month window surrounding the mini-budget announcement, and estimating the temporal dynamics of the incentives over this period. We focus on variation across weeks, and create an indicator variable for each week of our sample and include interaction terms between each of these indicator variables and Green_i. Formally, we estimate the following empirical specification with the initial loan rate as the outcome variable:

$$y_{ijblt} = \alpha + \beta \cdot \text{Green}_i + \sum_{t=1}^{T} \theta_t \cdot \mathbb{1}(t) \cdot \text{Green}_i + \lambda_{jblt} + \epsilon_{ijblt}, \tag{2}$$

where $\mathbb{1}(t)$ denotes the dummy variable for week t and λ_{jblt} represents product type (j) $\times$ borrower type (b) $\times$ lender (l) $\times$ week (t) fixed effects.

Figure 5 shows the estimates for the residential (Panel A) and investor (Panel B) segments of the market. We plot the estimated coefficients along with the corresponding 95% confidence intervals for the interaction terms between each weekly dummy and the indicator variable for green products. This event-study approach allows us to examine the time-series evolution of the difference in initial rate between green and comparable non-green products. We normalize this difference to zero in the first week of the estimation window, so all estimates are interpreted relative to this baseline.

[Insert Figure 5 here]

Most of the estimated coefficients are not statistically different from zero. The only exception is for the residential market which shows an *increase* in the initial rate of green products compared to non-green ones after the interest rate rise (Figure 5b). This is exactly the opposite of what the cash-flow channel would predict. If green products are relatively more likely to be used by lenders to attract new customers, and if in the immediate aftermath of the mini-budget announcement lenders are not as interested in attracting new borrowers (for instance, due to increased uncertainty), the response may be a reduction in the green compensation.

Figure 6 shows the results for the probability of cashback (Panel A) and cashback amount (Panel B) as outcome variables, for the owner-occupied segment. The probability of green loans offering cashback declines following the interest rate rise, though the change is not statistically significant. In any case, the decline in the probability of cashback is the opposite of what the cash-flow channel would predict. Focusing on the cashback amount (Panel B), we again

find no evidence that lenders improve the benefits of green products following the mini-budget announcement. Rather, sub-figure (d) documents a short-lived *negative* coefficient after the mini-budget announcement.

[Insert Figure 6 here]

Therefore, we do not find evidence in support of the cash-flow channel, and if anything the opposite seems to be the case.

4.2 Collateral value channel

To test the collateral channel, we analyze whether the financial incentives of green mortgages are relatively larger for products with a higher maximum LTV ratio compared to those with a lower maximum LTV ratio. Higher LTV loans have higher default risk, and in the event of a default, lenders are concerned with the property's ability to retain its value over time to avoid losses on the collateral. Therefore, under this channel, we would expect the benefits associated with green mortgages to be larger as the product's maximum LTV ratio increases.

We estimate Equation (1), with the green dummy interacted with maximum product LTV dummies as explanatory variables. We use different maximum product LTV cutoffs for the residential and the buy-to-let segments, as the distribution of this variable for green products is substantially different across the two market segments (Figure A5).

The first six columns of Table 10 show the results for the residential sector. The last two columns refer to the buy-to-let segment. For both segments, the omitted category is maximum LTV$\leq$65. The estimated coefficients on the interactions are always statistically insignificant in the residential segment. A similar conclusion holds for the investor market. The only exception are in columns (5) and (6) for the green products in the highest LTV bracket. The estimated positive coefficients are the opposite of what the collateral value channel would predict. Nonetheless, one should be careful in reading too much from the large estimate coefficient for loans with LTV>75 since a 75 is the typical maximum considered by the vast majority of lenders (Figure A5).

[Insert Table 10 here]

Overall, the results in this section do not support the hypothesis that the benefits of green mortgages are due to the lower default risk of the loans.

5 Customer acquisition

Lenders may offer green mortgages to attract environmentally conscientious customers. In a competitive market, these mortgages may serve as a mechanism for lenders to differentiate their products, expand the *menu* of contracts they offer, and cater to an increasingly large proportion of environmentally conscientious borrowers. While empirically testing this hypothesis is challenging, we present evidence that suggests that this may be an important determinant of at least some lenders' choice to offer these products.

We leverage the unique features of the UK mortgage market. As explained in section 2.2, UK mortgages tend to have an initial period of discounted rate, at the end of which it reverts to a significantly higher reversion rate. At this point, most borrowers refinance their loans. There are significant differences in the process of refinancing, depending on whether borrowers refinance with their current lender or a different one, and whether they wish to extract home equity in the process.

Loans for property acquisition require a full property valuation and affordability assessment. This is also the case for those borrowers refinancing a previous loan (without property acquisition) from a *new* lender, and those refinancing a previous loan with their current lender with equity extraction. However, the process of refinancing an existing loan with the same lender without equity extraction is much simpler and is less costly. It does not require a full property valuation (lenders update the value of the house using the evolution of local house price indices) nor an affordability assessment or proof of income. This simpler process is often known as "product transfer," as borrowers are simply transferred to a new product.

As a result of the significantly lower costs, most borrowers refinancing a loan do so with their existing lender (Belgibayeva et al., 2024). In contrast, the likelihood that borrowers switch lenders is much larger when purchasing a property. This, combined with fact that the loans on offer are differentially available to buyers and remortgagors allows us to test the hypothesis of whether green loans are being used to attract *new* business. If that is the case, the availability of green loans should be larger for house buyers than remortgagors.

Loans can be available for first-time buyers, second-time buyers, remortgagors or combinations of these borrower types. We construct a binary variable that takes the value of one if the product is available to house buyers only (and zero otherwise). In addition, we construct a dummy variable if the product is available to remortgagors (and zero otherwise). Some of the

latter may also be available to house buyers.

We then estimate Equation (1) with these indicator variables as outcomes. We exclude the interaction with borrower type in the fixed effects, as it would not allow us to estimate the model. Table 11 shows the results for these product availability variables. In Panel A we focus on the residential market. The estimated coefficient of 0.31 on Green in column (1) shows that the products are much more likely to be offered to buyers only. This effect remains both economically and statistically significant in column (2), with green products being 22% more likely to be offered to buyers only when considering only within-lender variation.

[Insert Table 11 here]

In columns (4) and (5) we show the corresponding specifications for the Available to remortgagors indicator as dependent variable. There are significantly fewer green products available to remortgagors, both compared to the market as a whole and when considering within-lender variation. The estimates are economically large, as remortgagors are 10-23% less likely to be offered a green mortgage.

As we have previously shown, there are two main types of benefits of green mortgages: cashback and preferential rate. We investigate whether the increased (decreased) availability of green products for buyers only (available to remortgagors) differs depending on the nature of the benefits provided. For this purpose, we extend our specification to include among the explanatory variables a cashback indicator and its interaction with the green indicator. The estimated coefficient on this variable shows how green products that offer cashback differ from green products that do not (of which most will have preferential rate as the stated benefit).

Columns (3) and (6) of Panel A of Table 11 show that the previously estimated effects are solely driven by green products offering cashback. The probability that they are offered to buyers only is 23% higher (0.35-0.12) than green products that do not offer cashback. In addition, the probability that green cashback loans are available to remortgagors is 12% lower (-0.40+0.28) than green loans without cashback offers. The sum of the estimated coefficients is statistically different from zero in both cases, with *p-values* of 0.03 and 0.02, respectively. And in fact the latter are 7% more likely to be available to remortgagors than the non-green non-cashback loan offered by the same lender on the same day (as shown in the first row of column (6)). Interestingly, as the back-of-the-envelope calculations have shown, these products offer considerably smaller financial benefits, in sharp contrast with those with preferential rate.

Panel B shows the results for the investor market. In contrast to the owner-occupied sector, most of the coefficients are statistically insignificant. These results suggest that lenders use green cashback loans to attract new business in the owner-occupied sector of the market, but are less keen on offering the loans for those seeking to remortgage (which typically includes a disproportionate number of their existing customers).

The evidence that cashback offers on green mortgages may be used to attract customers raises the question of whether the use of cashback is specific to green loans or whether lenders apply this incentive as part of a broader customer acquisition strategy. To address this question, we study the relationship between cashback offers on green and non-green products by the same lender. We first compute the share of both green and non-green products offering cashback for each lender-day pair in the residential segment. We then group the non-green cashback share into equal-sized bins, calculate the mean for each variable within each bin, and in Figure 7a plot these data points, residualized by day fixed effects. Figure 7b follows the same procedure for the average cashback amount.

[Insert Figure 7]

These figures show a strong positive relationship: lenders who frequently offer cashback on non-green products (x-axis) are also more likely to provide cashback on green products (y-axis), with a line of best fit slope of 0.83. Similarly, the relationship between the average cashback amount on green and non-green products is positive and significant. This evidence strongly supports the view that cashback offers on green mortgages are part of a broader customer acquisition strategy that lenders apply across both green and non-green products.

6 Conclusion

In this paper, we study the prevalence of green mortgages in the UK. Green mortgages are designed to incentivize borrowers to purchase energy-efficient properties or retrofit existing ones, with financial benefits such as lower interest rates and cashback offers. We find that these products are increasingly prevalent in the market.

Interestingly, we find significant heterogeneity in the nature of the financial benefits offered, both across market segments (owner-occupied and investor) and lenders. In the owner-occupied

segment, most products offer cashback incentives. Lenders tend to specialize on one of these benefits. In the investor market, almost all loans offer preferential rate.

Our estimates of the magnitude of the financial benefits of green products also reveal substantial heterogeneity in the financial benefits provided to borrowers through different incentives. Green products offering a preferential rate provide a 35 basis point discount compared to similar non-green products available in the market on the same day and a 9 basis point discount when compared to similar non-green products from the same lender on the same day. For a typical mortgage borrower, these translate to present value gains of £3,009 and £774, respectively. In contrast, green products offering cashback provide much smaller financial benefits, ranging from £211 to £241.

We test two potential explanations for why lenders offer green mortgages and their associated incentives. The first is risk-based: more energy-efficient homes might pose lower default risk due to the cash-flow benefits of reduced utility costs and the higher collateral value of green properties. We do not find evidence in support of this explanation. Our results suggest that lenders offer green mortgages as a strategy to attract borrowers, using these products as a way to differentiate themselves in a competitive market. The incentives for lenders to attract new borrowers are smaller during the remortgaging stage, as borrowers are significantly less likely to switch lenders when remortgaging compared to when purchasing a home. Supporting the customer acquisition explanation, we observe that green mortgages, particularly those offering cashback incentives, are more frequently available to homebuyers only and less commonly offered to remortgagors.

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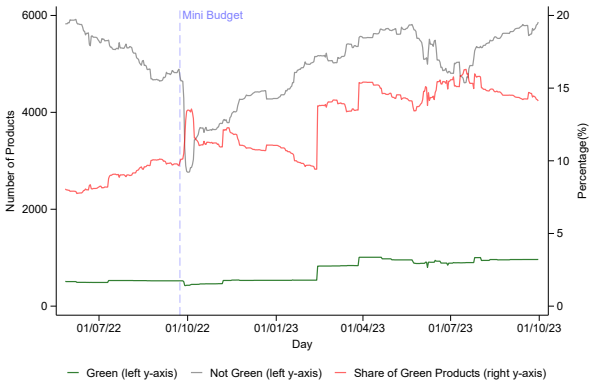
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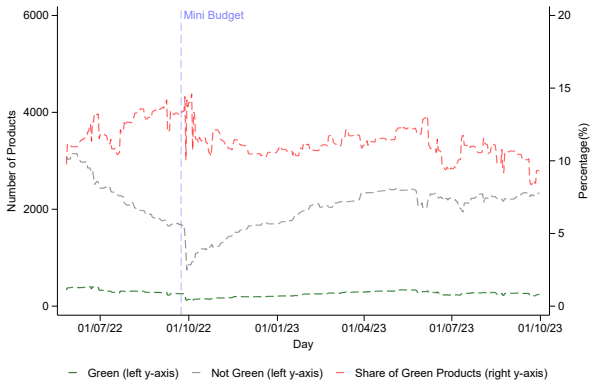
7 Figures

Figure 1. Daily Count of the Number of Green Mortgage Products in the UK

(a) Residential



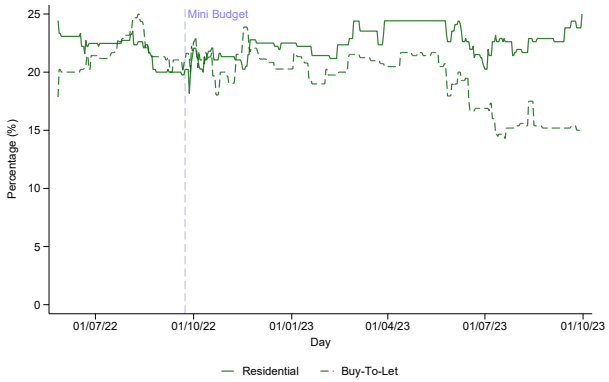
(b) Buy-to-Let



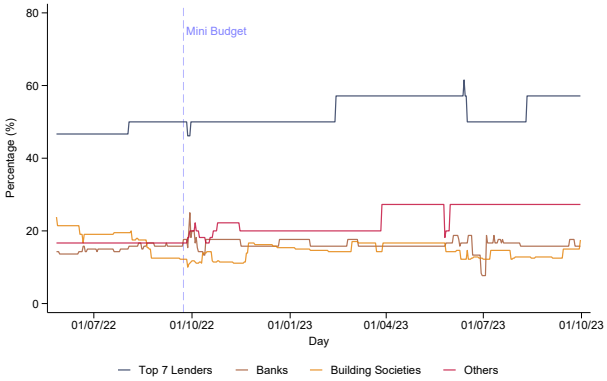
This figure shows the time-series of the number of products on offer in the market (left y-axis) and the share of green products (right y-axis). Figure 1a refers to the residential market, and Figure 1b to the buy-to-let segment. The vertical line identifies the mini-budget announcement of 23 September 2022. Appendix B provides a detailed description of the variables.

Figure 2. Daily Share of Lenders Offering Green Mortgages

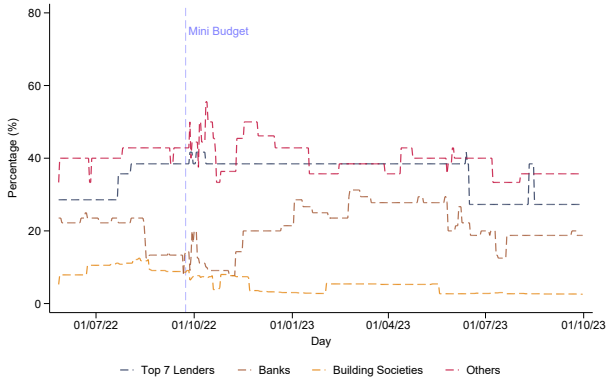
(a) Residential and Buy-to-Let, All Lenders



(b) Residential, by Lender Category



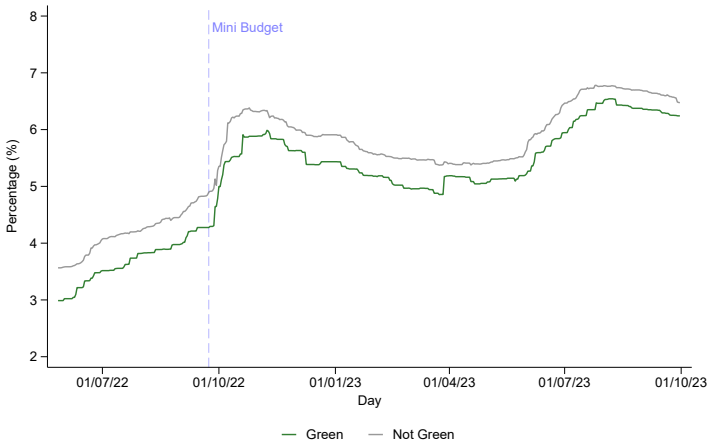
(c) Buy-to-Let, by Lender Category



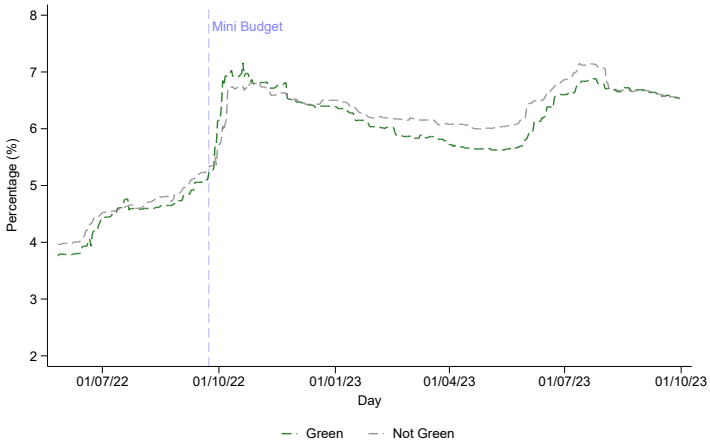
This figure shows the share of lenders offering green mortgages in the UK mortgage market. Figure 2a shows the overall average for both residential and buy-to-let segments. Figures 2b and 2c show the share by lender category (top seven lenders, banks, building societies and others) in the residential and buy-to-let segments, respectively. The shares are computed based on the original classification of lenders provided by Moneyfacts. The vertical line identifies the mini-budget announcement of 23 September 2022. Appendix B provides a detailed description of the variables.

Figure 3. Average Initial Rate

(a) Residential



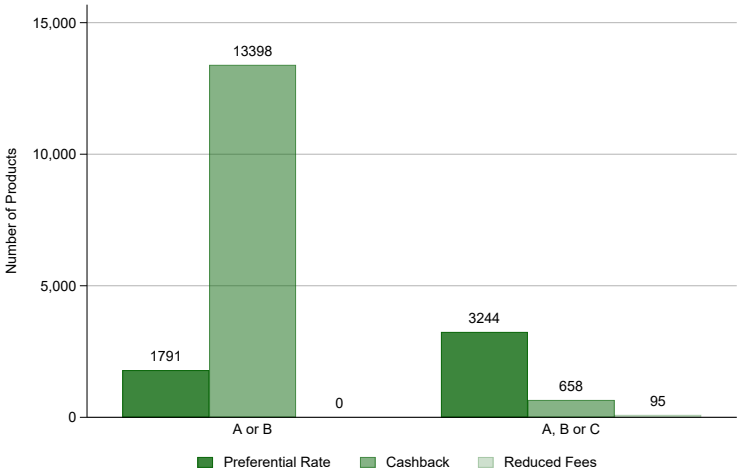
(b) Buy-to-Let



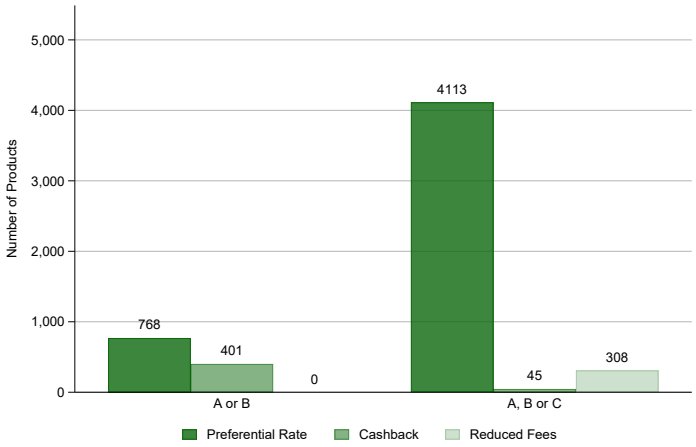
This figure shows the time-series of the average initial rate for non-green and green products for the residential (Figure 3a) and buy-to-let (Figure 3b) segments of the market. The vertical line identifies the mini-budget announcement of 23 September 2022. Appendix B provides a detailed description of the variables.

Figure 4. Stated Benefits of Green Mortgages

(a) Residential



(b) Buy-to-Let

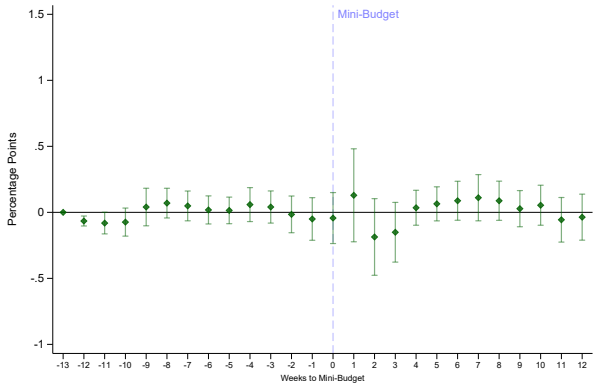


This figure provides the count of unique green products that state "Preferential Rate", "Cashback" or "Reduced Fees" in their green description. The benefits are not mutually exclusive, as a product may list more than one benefit. Figure 4a refers to the residential market, while Figure 4b refers to the buy-to-let segment. For both segments, we show the count of products separately for EPC ratings "A or B" and "A, B or C". Appendix B provides a detailed description of the variables.

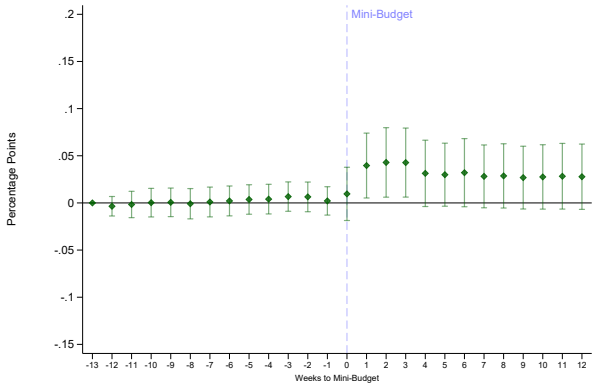
Figure 5. Initial Rate Around Mini-Budget Announcement

Panel A: Residential

(a) Product × Borrower × Week

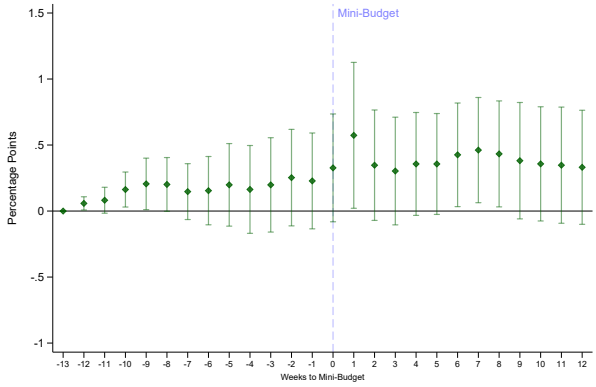


(b) Lender × Product × Borrower × Week

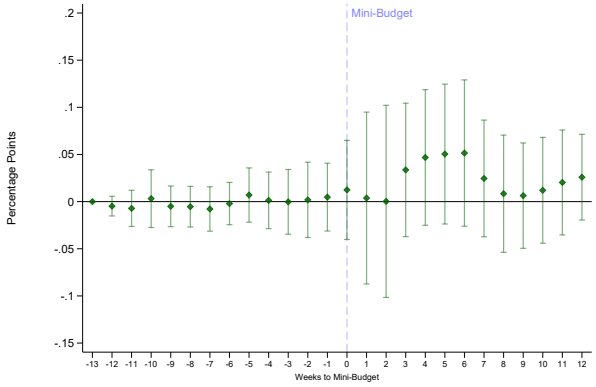


Panel B: Buy-to-Let

(c) Product × Borrower × Week



(d) Lender × Product × Borrower × Week

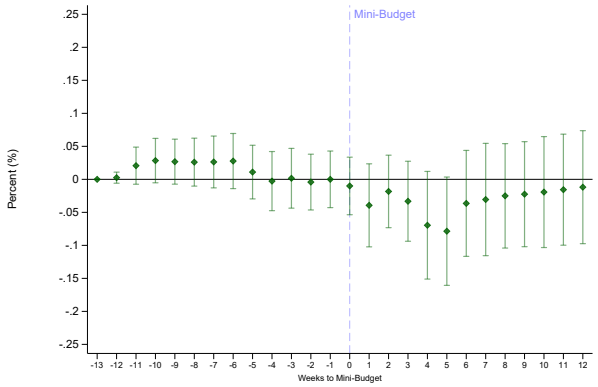


This figure shows the estimated coefficients and 95% confidence intervals of estimating Equation (2) with the initial loan rate as the outcome variable. We narrow our analysis to a three-month window surrounding the mini-budget announcement on 23 September 2022. Panel A refers to the residential market, while Panel B focus on the buy-to-let segment. Figures 5a and 5c show the estimation results when including Product Type × Borrower Type × Week fixed effects. Figures 5b and 5d show the estimation results when including Lender × Product Type × Borrower Type× Week fixed effects. Product types are defined as groups of products that share the same interest rate type (fixed or variable), the same initial interest rate fixation period, and the same maximum loan-to-value ratio. Borrower types refer to the categories of borrowers for which the product is available, including first-time buyers, second-time buyers, remortgagors and others. Products may be available to any combination of these four borrower types. The first week of the estimation window is omitted as the reference week. We use the original classification of lenders provided by Moneyfacts. Appendix B provides a detailed description of the variables.

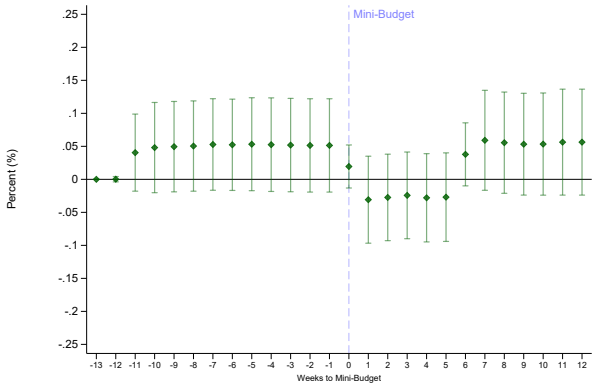
Figure 6. Cashback Around Mini-Budget Announcement in the Residential Segment

Panel A: Probability of Cashback

(a) Product × Borrower × Week

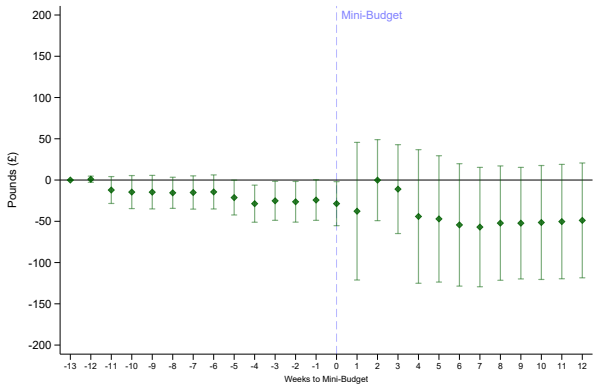


(b) Lender × Product × Borrower × Week

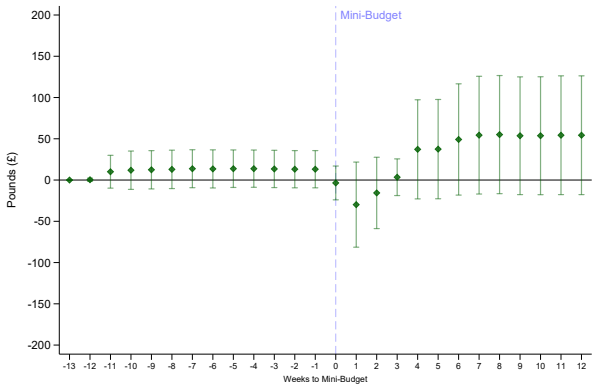


Panel B: Cashback Amount

(c) Product × Borrower × Week



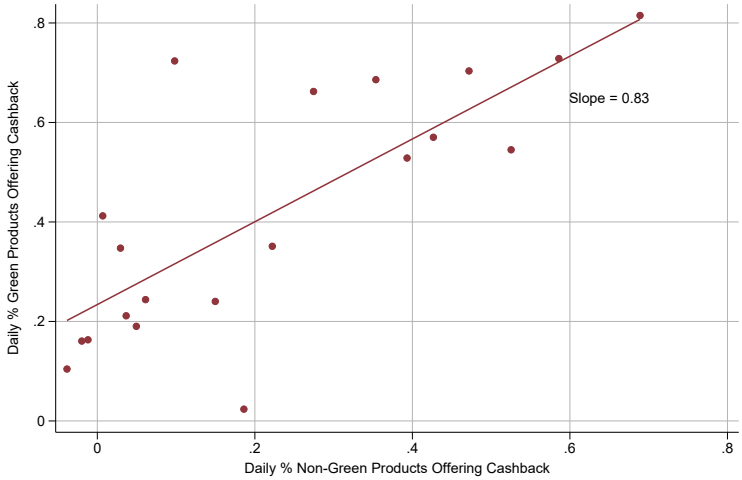
(d) Lender × Product × Borrower × Week



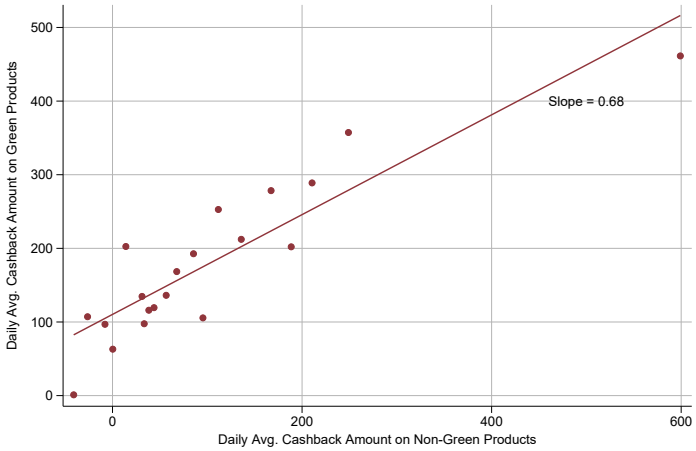
This figure shows the estimated coefficients and 95% confidence intervals of estimating Equation (2) with 𝟙(cashback) (Panel A) and cashback amount (Panel B) as outcome variables. These estimates refer to the residential market. We narrow our analysis to a three-month window surrounding the mini-budget announcement on 23 September 2022. Figures 6a and 6c show the estimation results when including Product Type × Borrower Type × Week fixed effects. Figures 6b and 6d show the estimation results when including Lender × Product Type × Borrower Type × Week fixed effects. Product types are defined as groups of products that share the same interest rate type (fixed or variable), the same initial interest rate fixation period, and the same maximum loan-to-value ratio. Borrower types refer to the categories of borrowers for which the product is available, including first-time buyers, second-time buyers, remortgagors and others. Products may be available to any combination of these four borrower types. The first week of the estimation window is omitted as the reference week. We use the original classification of lenders provided by Moneyfacts. Appendix B provides a detailed description of the variables.

Figure 7. Relationship Between Daily Share of Green and Non-Green Products Offering Cashback, by Lender

(a) 𝟙(Cashback)



(b) Cashback Amount (£)



These figures present bin-scatter plots illustrating the relationship between the daily share of green products (y-axis) and non-green products (x-axis) offering cashback (Figure 7a), as well as the corresponding cashback amount (Figure 7b). In Figure 7a, we calculate the share of both green and non-green products offering cashback for each lender-day pair. We then group the non-green cashback share into equal-sized bins, compute the mean for each variable within each bin, and plot these data points, residualized by day fixed effects. Figure 7b follows the same procedure, but for the average cashback amount. Both plots focus on the residential segment. Appendix B provides a detailed description of the variables.

8 Tables

Table 1. Energy Performance of Dwellings in the UK, 2022

Dwelling Age	% of Properties Within Energy Efficiency Rating					Energy Use (KWh/m^2/year)	Energy Cost (£/year)	CO_2 Emissions Tonnes/Year	Number of Dwellings (000s)
	A/B	C	A/B/C	D	E/F/G				
Pre-1919		21	21	56	23	275	1,894	5.7	5,099
1919-44		28	28	63	9	247	1,592	4.4	3,801
1945-64	1	47	48	45	6	231	1,370	3.7	4,550
1965-80	1	49	49	43	7	235	1,346	3.7	4,674
1981-90	3	57	60	34	6	227	1,251	3.4	1,660
Post-1990	13	70	83	15	2	176	1,074	2.8	5,376

This table shows the energy performance of the stock of dwellings in the UK in 2022, by dwelling age. It also presents estimates of the energy use, associated cost and CO_2 emissions. Energy costs are at constant 2012 prices. Source: Energy Housing Survey 2022-23. For details: Energy Housing Survey Technical Report.

Table 2. Green Mortgages Requirements

EPC Rating	Current EPC	Improving EPC	Total
Not Reported	0	612	612
A	4	0	3
A or B	15,095	55	15,150
A, B or C	7,857	45	7,902
E or Above	0	9	9
Total	22,956	721	23,677

This table presents the number of unique green products that require each specific EPC ratings. We also categorize each product based on whether it targets properties with a current required EPC rating or if it allows for future energy improvements. We extract both variables from the green description. Appendix B provides a detailed description of the variables. The 612 cases for which the EPC rating is not reported have the following description: "Cash-back for the purchase or remortgage of a property when the energy efficiency rating is improved by 10 or more SAP points within 12 months of completion."

Table 3. Summary Statistics: Green and Not Green Mortgages

	Panel A: Residential							
	Green ($n = 346,777$)				Not Green ($n = 2,464,183$)			
	Mean	Std. Dev.	p25	p75	Mean	Std. Dev.	p25	p75
Fixation Term (Years)	3.75	2.28	2.00	5.00	3.43	2.08	2.00	5.00
Maximum LTV Ratio (%)	78.43	10.62	75.00	85.00	77.86	11.89	70.00	85.00
Fixed Rate Mortgage (Binary)	0.90	0.30	1.00	1.00	0.85	0.36	1.00	1.00
Available to First Time Buyers (Binary)	0.69	0.46	0.00	1.00	0.66	0.47	0.00	1.00
Available to Second Time Buyers (Binary)	0.64	0.48	0.00	1.00	0.65	0.48	0.00	1.00
Available to Remortgagors (Binary)	0.36	0.48	0.00	1.00	0.60	0.49	0.00	1.00
Available to Other Borrowers (Binary)	0.00	0.00	0.00	0.00	0.07	0.26	0.00	0.00
Initial Rate (%)	5.26	1.18	4.43	6.14	5.51	1.52	4.48	6.37
Reversion Rate (%)	7.18	1.43	6.20	7.99	6.86	1.44	5.74	7.87
Cashback (Binary)	0.73	0.45	0.00	1.00	0.29	0.45	0.00	1.00
Cashback Amount (£)	333.91	317.11	0.00	500.00	121.55	241.75	0.00	250.00
Total Flat Fees (£)	517.34	523.32	0.00	999.00	626.91	613.89	0.00	999.00
Total Percent Fees (%)	0.00	0.04	0.00	0.00	0.02	0.13	0.00	0.00
Stated Benefit (Green): Preferential Rate (Binary)	0.39	0.49	0.00	1.00	–	–	–	–
Stated Benefit (Green): Cashback (Binary)	0.76	0.43	1.00	1.00	–	–	–	–
Stated Benefit (Green): Reduced Fees (Binary)	0.01	0.08	0.00	0.00	–	–	–	–

	Panel B: Buy-to-Let							
	Green ($n = 129,365$)				Not Green ($n = 1,010,984$)			
	Mean	Std. Dev.	p25	p75	Mean	Std. Dev.	p25	p75
Fixation Term (Years)	3.97	1.81	2.00	5.00	3.33	1.77	2.00	5.00
Maximum LTV Ratio (%)	70.65	7.32	65.00	75.00	71.18	7.25	65.00	75.00
Fixed Rate Mortgage (Binary)	0.91	0.28	1.00	1.00	0.79	0.41	1.00	1.00
Available to First Time Buyers (Binary)	0.10	0.30	0.00	0.00	0.18	0.39	0.00	0.00
Available to Second Time Buyers (Binary)	0.81	0.40	1.00	1.00	0.82	0.38	1.00	1.00
Available to Remortgagors (Binary)	0.80	0.40	1.00	1.00	0.81	0.39	1.00	1.00
Available to Other Borrowers (Binary)	0.04	0.19	0.00	0.00	0.08	0.27	0.00	0.00
Initial Rate (%)	5.70	1.30	4.84	6.65	5.91	1.69	4.84	6.75
Reversion Rate (%)	7.51	1.51	6.24	8.59	7.55	1.56	6.25	8.74
Cashback (Binary)	0.27	0.44	0.00	1.00	0.15	0.36	0.00	0.00
Cashback Amount (£)	147.10	286.61	0.00	300.00	51.92	128.93	0.00	0.00
Total Flat Fees (£)	731.81	1,173.26	0.00	995.00	842.62	907.12	0.00	1,495.00
Total Percent Fees (%)	1.51	1.23	0.00	2.00	1.64	1.33	0.00	2.00
Stated Benefit (Green): Preferential Rate (Binary)	0.78	0.41	1.00	1.00	–	–	–	–
Stated Benefit (Green): Cashback (Binary)	0.14	0.35	0.00	0.00	–	–	–	–
Stated Benefit (Green): Reduced Fees (Binary)	0.06	0.23	0.00	0.00	–	–	–	–

This table shows summary statistics for the main variables used in the paper, separately for green and non-green mortgage products. These statistics are calculated using the full dataset at the product-day level. Panel A covers the residential segment, while Panel B refers to the buy-to-let segment. Appendix B provides a detailed description of the variables.

Table 4. Average Product Characteristics, by Lender Category

	Panel A: Residential							
	Top 7 Lender		Banks		Building Societies		Others	
Number of Green Observations	226,266		63,024		6,791		50,696	
Number of Non-Green Observations	826,948		457,456		551,451		628,328	
Share of Green	0.21		0.12		0.01		0.07	
	Green	Non-Green	Green	Non-Green	Green	Non-Green	Green	Non-Green
Fixation Term (Years)	4.07	3.76	3.17	3.46	1.25	3.17	3.38	3.20
Maximum LTV Ratio (%)	78.36	78.73	78.19	77.81	84.03	80.17	78.25	74.74
Fixed Rate Mortgage (Binary)	0.92	0.86	0.87	0.94	0.15	0.70	0.93	0.90
Available to First Time Buyers (Binary)	0.61	0.47	0.66	0.72	0.99	0.70	1.00	0.83
Available to Second Time Buyers (Binary)	0.55	0.44	0.66	0.77	0.99	0.68	1.00	0.81
Available to Remortgagors (Binary)	0.22	0.41	0.43	0.71	0.62	0.62	0.89	0.76
Available to Other Borrowers (Binary)	0.00	0.14	0.00	0.02	0.00	0.09	0.00	0.00
Initial Rate (%)	5.00	4.90	5.07	5.45	4.95	4.86	6.74	6.92
Reversion Rate (%)	7.03	6.66	6.41	6.83	6.66	6.27	8.74	7.78
Cashback (Binary)	0.92	0.30	0.53	0.38	0.08	0.25	0.21	0.23
Cashback Amount (£)	366.76	116.08	397.04	187.13	18.00	95.88	150.61	103.53
Total Flat Fees (£)	550.72	586.16	165.71	700.68	565.51	571.49	799.05	676.79
Total Percent Fees (%)	0.00	0.00	0.00	0.04	0.24	0.05	0.00	0.02
Stated Benefit (Green): Preferential Rate (Binary)	0.11	–	1.00	–	0.92	–	0.79	–
Stated Benefit (Green): Cashback (Binary)	0.97	–	0.51	–	0.08	–	0.21	–
Stated Benefit (Green): Reduced Fees (Binary)	0.00	–	0.00	–	0.00	–	0.04	–

	Panel B: Buy-to-Let							
	Top 7 Lender		Banks		Building Societies		Others	
Number of Green Observations	30,936		21,931		1,570		74,928	
Number of Non-Green Observations	223,841		161,642		202,751		422,750	
Share of Green	0.12		0.12		0.007		0.15	
	Green	Non-Green	Green	Non-Green	Green	Non-Green	Green	Non-Green
Fixation Term (Years)	3.56	3.43	3.94	3.51	2.79	3.08	4.17	3.33
Maximum LTV Ratio (%)	67.00	67.80	70.24	72.34	77.05	70.86	72.14	72.69
Fixed Rate Mortgage (Binary)	1.00	0.89	0.90	0.90	0.43	0.60	0.89	0.79
Available to First Time Buyers (Binary)	0.20	0.12	0.10	0.05	0.00	0.14	0.05	0.29
Available to Second Time Buyers (Binary)	0.35	0.66	0.87	0.89	0.95	0.67	0.97	0.95
Available to Remortgagors (Binary)	0.65	0.61	0.80	0.80	0.73	0.74	0.86	0.96
Available to Other Borrowers (Binary)	0.00	0.11	0.13	0.05	0.00	0.13	0.03	0.04
Initial Rate (%)	5.04	5.04	5.51	5.67	4.33	5.08	6.05	6.87
Reversion Rate (%)	7.44	7.27	7.22	7.76	6.37	6.74	7.66	8.06
Cashback (Binary)	0.33	0.33	0.25	0.11	0.53	0.19	0.24	0.05
Cashback Amount (£)	98.37	122.53	80.86	40.21	203.23	61.64	185.48	14.35
Total Flat Fees (£)	1,471.05	940.84	651.44	928.07	820.24	1,105.78	106.83	464.09
Total Percent Fees (%)	0.00	0.89	1.59	1.85	0.00	0.49	1.67	1.96
Stated Benefit (Green): Preferential Rate (Binary)	1.00	–	0.87	–	0.46	–	0.67	–
Stated Benefit (Green): Cashback (Binary)	0.00	–	0.00	–	0.05	–	0.24	–
Stated Benefit (Green): Reduced Fees (Binary)	0.00	–	0.00	–	0.00	–	0.10	–

This table shows average product characteristics for the main variables used in the paper. The averages are calculated using the full dataset at the product-day level. Panel A covers the residential segment, while Panel B refers to the buy-to-Let segment. Lender type defined by the ultimate ownership of each lender (consolidated lender classification). In the residential (buy-to-let) segment, there are 15 (14) top seven lenders, 22 (20) other banks, 43 (40) building societies and 13 (18) other lenders. In the buy-to-let segment, the total stated benefits of green mortgages (last three rows) sum to less than one because some products in this segment do not disclose specific benefits in their green mortgage descriptions. Appendix B provides a detailed description of the variables.

Table 5. Incentives: Interest Rate on Products Offered

	Panel A: All Green Products					
Dependent Variable:	Initial Rate (%)					
Segment:	Residential			Buy-to-Let		
	(1)	(2)	(3)	(4)	(5)	(6)
Green	-0.39**	-0.24*	-0.04**	-0.18	-0.13	-0.05
	(0.18)	(0.14)	(0.02)	(0.23)	(0.19)	(0.05)
Constant	5.53***	5.51***	5.52***	5.91***	5.92***	5.96***
	(0.17)	(0.13)	(0.00)	(0.19)	(0.15)	(0.01)
Observations	2,802,916	2,775,739	2,555,194	1,138,870	1,126,318	1,062,067
Adjusted R-Squared	0.54	0.65	0.95	0.53	0.62	0.94
Mean Dep. Variable	5.48	5.48	5.51	5.89	5.90	5.95
Fixed Effects:						
Product × Day	Yes			Yes		
Product × Borrower × Day		Yes			Yes	
Product × Borrower × Day × Lender			Yes			Yes

	Panel B: Green Products Stating "Preferential Rate" as a Benefit					
Dependent Variable:	Initial Rate (%)					
Segment:	Residential			Buy-to-Let		
	(1)	(2)	(3)	(4)	(5)	(6)
Green	-0.35	-0.35*	-0.09**	-0.36	-0.30	-0.11***
	(0.30)	(0.19)	(0.04)	(0.23)	(0.18)	(0.01)
Constant	5.53***	5.53***	5.56***	5.90***	5.91***	5.94***
	(0.17)	(0.13)	(0.00)	(0.19)	(0.15)	(0.00)
Observations	2,591,029	2,563,852	2,344,562	1,110,279	1,097,708	1,033,411
Adjusted R-Squared	0.53	0.64	0.95	0.53	0.62	0.94
Mean Dep. Variable	5.51	5.52	5.55	5.87	5.88	5.93
Fixed Effects:						
Product × Day	Yes			Yes		
Product × Borrower × Day		Yes			Yes	
Product × Borrower × Day × Lender			Yes			Yes

This table presents estimates of the difference in the initial rate between green and non-green products, based on the model specified in Equation 1. Panel A considers all green products, whereas Panel B focus exclusively on green products that state "preferential rate" as a financial benefit in the green description. For both panels, columns (1)-(3) refer to the residential segment, while columns (4)-(6) refer to the buy-to-let market. These estimates are based on the whole sample period (May/27/2022 to September/30/2023). Product types, included in the fixed effects, are defined as groups of products that share the same interest rate type (fixed or variable), the same initial interest rate fixation period, and the same maximum loan-to-value ratio. Borrower types refer to the categories of borrowers for which the product is available, including first-time buyers, second-time buyers, remortgagors and others. Products may be available to any combination of these four borrower types. We use the original classification of lenders provided by Moneyfacts. Appendix B provides a detailed description of the variables. Standard errors are clustered by lender. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 6. Incentives: Cashback Offered on Mortgages in the Residential Segment

	Panel A: All Green Products					
Dependent Variable:	𝟙(Cashback)			Cashback Amount (£)		
	(1)	(2)	(3)	(4)	(5)	(6)
Green	0.42***	0.34***	0.39**	206.17***	158.60***	145.24**
	(0.13)	(0.13)	(0.15)	(52.85)	(41.50)	(65.51)
Constant	0.29***	0.30***	0.30***	122.50***	128.96***	133.55***
	(0.03)	(0.03)	(0.02)	(16.39)	(15.96)	(8.75)
Observations	2,802,916	2,775,739	2,555,194	2,802,812	2,775,635	2,555,174
Adjusted R-Squared	0.13	0.26	0.60	0.11	0.24	0.63
Mean Dep. Variable	0.34	0.34	0.35	147.98	148.71	152.95
Fixed Effects:						
Product × Day	Yes			Yes		
Product × Borrower × Day		Yes			Yes	
Product × Borrower × Day × Lender			Yes			Yes

	Panel B: Green Products Stating "Cashback" as a Benefit					
Dependent Variable:	𝟙(Cashback)			Cashback Amount (£)		
	(1)	(2)	(3)	(4)	(5)	(6)
Green	0.62***	0.53***	0.52***	295.98***	241.76***	211.25***
	(0.06)	(0.08)	(0.14)	(55.79)	(43.64)	(43.75)
Constant	0.29***	0.30***	0.31***	123.20***	128.95***	135.22***
	(0.03)	(0.03)	(0.01)	(16.74)	(16.22)	(4.61)
Observations	2,718,053	2,691,805	2,469,256	2,717,949	2,691,701	2,469,236
Adjusted R-Squared	0.19	0.30	0.63	0.15	0.27	0.67
Mean Dep. Variable	0.35	0.35	0.36	151.74	152.49	157.48
Fixed Effects:						
Product × Day	Yes			Yes		
Product × Borrower × Day		Yes			Yes	
Product × Borrower × Day × Lender			Yes			Yes

This table presents estimates of the difference in the probability of cashback and the cashback amount between green and non-green products, based on the model specified in Equation 1. Panel A considers all green products, whereas Panel B focus exclusively on green products that state "cashback" as a financial benefit in the green description. These estimates refer to the residential segment and are based on the whole sample period (May/27/2022 to September/30/2023). Product types, included in the fixed effects, are defined as groups of products that share the same interest rate type (fixed or variable), the same initial interest rate fixation period, and the same maximum loan-to-value ratio. Borrower types refer to the categories of borrowers for which the product is available, including first-time buyers, second-time buyers, remortgagors and others. Products may be available to any combination of these four borrower types. We use the original classification of lenders provided by Moneyfacts. Appendix B provides a detailed description of the variables. Standard errors are clustered by lender. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 7. Adjusted-R^2 Across Various Fixed Effects Specifications

Dependent Variable:	Initial Rate (%)	𝟙(Cashback)	Cashback Amount (£)
Fixed Effects Specification:			
Residential			
Product × Borrower × Day	0.65	0.26	0.24
Product × Borrower × Day × Lender Category	0.83	0.34	0.43
Product × Borrower × Day × Lender	0.95	0.60	0.63
Buy-to-Let:			
Product × Borrower × Day	0.62	0.18	0.16
Product × Borrower × Day × Lender Category	0.73	0.32	0.29
Product × Borrower × Day × Lender	0.94	0.50	0.45

This table presents the adjusted R-squared values for different fixed effects specifications, based on the model specified in Equation 1, for both the residential and BTL segments. We consider all green products, as in Panel A of Tables 5 and 6. These estimates are based on the whole sample period (May/27/2022 to September/30/2023). Product types, included in the fixed effects, are defined as groups of products that share the same interest rate type (fixed or variable), the same initial interest rate fixation period, and the same maximum loan-to-value ratio. Borrower types refer to the categories of borrowers for which the product is available, including first-time buyers, second-time buyers, remortgagors and others. Products may be available to any combination of these four borrower types. We use the original classification of lenders provided by Moneyfacts. Appendix B provides a detailed description of the variables. Standard errors are clustered by lender. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 8. Incentives: Interest Rate and Cashback on Products Offered, by Top Seven Lenders Only

	Panel A: Green Products Stating "Preferential Rate" as a Benefit					
Dependent Variable:	Initial Rate (%)					
Segment:	Residential			Buy-to-Let		
	(1)	(2)	(3)	(4)	(5)	(6)
Green	-0.19***	-0.21***	-0.20***	-0.19**	-0.17***	-0.10***
	(0.03)	(0.04)	(0.01)	(0.07)	(0.05)	(0.03)
Constant	4.90***	4.90***	4.90***	5.06***	5.06***	5.04***
	(0.02)	(0.02)	(0.00)	(0.03)	(0.02)	(0.00)
Observations	849,468	845,059	822,738	254,006	246,977	230,450
Adjusted R-Squared	0.90	0.91	0.96	0.84	0.85	0.85
Mean Dep. Variable	4.90	4.90	4.89	5.04	5.04	5.03
Fixed Effects:						
Product × Day	Yes			Yes		
Product × Borrower × Day		Yes			Yes	
Product × Borrower × Day × Lender			Yes			Yes

	Panel B: Green Products Stating "Cashback" as a Benefit					
Dependent Variable:	𝟙(Cashback)			Cashback Amount (£)		
Segment:	Residential					
	(1)	(2)	(3)	(4)	(5)	(6)
Green	0.61***	0.50***	0.55***	249.04***	187.33***	214.76***
	(0.08)	(0.14)	(0.16)	(47.35)	(29.39)	(31.83)
Constant	0.30***	0.33***	0.31***	117.05***	129.52***	122.25***
	(0.05)	(0.05)	(0.03)	(22.58)	(16.79)	(6.86)
Observations	1,042,996	1,038,697	1,015,759	1,042,996	1,038,697	1,015,759
Adjusted R-Squared	0.27	0.44	0.60	0.23	0.61	0.80
Mean Dep. Variable	0.43	0.43	0.43	169.36	169.03	168.56
Fixed Effects:						
Product × Day	Yes			Yes		
Product × Borrower × Day		Yes			Yes	
Product × Borrower × Day × Lender			Yes			Yes

This table presents estimates of the difference in the initial rate, probability of cashback and the cashback amount between green and non-green products, based on the model specified in Equation 1. We restrict the sample to the top seven lenders. We consider all green products. In Panel A, columns (1)-(3) refer to the residential segment, while columns (4)-(6) refer to the buy-to-let market. In Panel B, all columns refer to the residential segment. These estimates are based on the whole sample period (May/27/2022 to September/30/2023). Product types, included in the fixed effects, are defined as groups of products that share the same interest rate type (fixed or variable), the same initial interest rate fixation period, and the same maximum loan-to-value ratio. Borrower types refer to the categories of borrowers for which the product is available, including first-time buyers, second-time buyers, remortgagors and others. Products may be available to any combination of these four borrower types. We use the original classification of lenders provided by Moneyfacts. Appendix B provides a detailed description of the variables. Standard errors are clustered by lender. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 9. Interaction between incentives on green mortgages and contractual features

	Residential Segment				
Dependent Variable:	Initial Rate (%)	𝟙(Cashback)	Cashback amount (£)	Flat fees (£)	Reversion Rate (%)
	(1)	(2)	(3)	(4)	(5)
Green × Stated Benefit: Cashback	-0.01	0.66***	281.50***	-23.66	-0.00
	(0.00)	(0.14)	(29.16)	(26.37)	(0.00)
Green × Stated Benefit: Preferential Rate	-0.20***	-0.12	-119.11	116.08*	-0.00*
	(0.06)	(0.11)	(94.06)	(65.89)	(0.00)
Green × Stated Benefit: Both	0.05	0.15	34.31	87.05	-0.00*
	(0.13)	(0.14)	(40.06)	(170.35)	(0.00)
Constant	5.52***	0.30***	132.93***	611.77***	6.94***
	(0.00)	(0.01)	(3.73)	(3.95)	(0.00)
Observations	2,555,156	2,555,156	2,555,136	2,531,765	2,428,942
Adjusted R-Squared	0.95	0.65	0.66	0.22	0.99
Mean Dep. Variable	5.51	0.35	152.95	615.25	6.94
Fixed Effects:					
Product × Borrower × Day × Lender	Yes	Yes	Yes	Yes	Yes

This table presents estimates of the difference in the contractual features between green and non-green products, based on the model specified in Equation 1, for different incentives. Specifically, we split the variable Green in three categories: (i) green products offering preferential rate only; (ii) green products cashback only; (iii) green products offering both incentives. We focus on the residential segment. These estimates are based on the whole sample period (May/27/2022 to September/30/2023). Product types, included in the fixed effects, are defined as groups of products that share the same interest rate type (fixed or variable), the same initial interest rate fixation period, and the same maximum loan-to-value ratio. Borrower types refer to the categories of borrowers for which the product is available, including first-time buyers, second-time buyers, remortgagors and others. Products may be available to any combination of these four borrower types. We use the original classification of lenders provided by Moneyfacts. Appendix B provides a detailed description of the variables. Standard errors are clustered by lender. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 10. Screening on Default Risk: Heterogeneity by Loan-to-Value Ratios

Segment:	Residential						Buy-to-Let	
Dependent Variable:	Initial Rate (%)		𝟙(Cashback)		Cashback Amount (£)		Initial Rate (%)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Green	-0.39	-0.05*	0.40***	0.39**	168.57***	131.84**	-0.17	-0.10***
	(0.24)	(0.02)	(0.13)	(0.17)	(34.06)	(65.85)	(0.19)	(0.01)
Green ×	-0.01	-0.02	-0.11	-0.09	-19.51	-14.54		
65 < LTV Ratio ≤ 75	(0.12)	(0.01)	(0.09)	(0.06)	(46.30)	(38.36)		
Green ×	0.23	0.01	-0.09	-0.01	-12.61	26.37		
75 < LTV Ratio ≤ 85	(0.19)	(0.02)	(0.08)	(0.07)	(46.74)	(42.69)		
Green ×	0.36	0.03	-0.01	0.12	-1.15	41.74		
LTV Ratio > 85	(0.25)	(0.02)	(0.07)	(0.08)	(28.33)	(29.55)		
Green ×							-0.33	0.00
LTV Ratio = 70							(0.22)	(0.01)
Green ×							0.09	0.05
LTV Ratio = 75							(0.19)	(0.06)
Green ×							0.45***	0.35***
LTV Ratio > 75							(0.17)	(0.10)
Constant	5.51***	5.52***	0.30***	0.30***	128.94***	133.48***	5.92***	5.96***
	(0.13)	(0.00)	(0.03)	(0.02)	(15.96)	(8.65)	(0.15)	(0.00)
Observations	2,775,739	2,555,194	2,775,739	2,555,194	2,775,635	2,555,174	1,126,318	1,062,067
Adjusted R-Squared	0.65	0.95	0.26	0.60	0.24	0.63	0.62	0.94
Mean Dep. Variable	5.48	5.51	0.34	0.35	148.71	152.95	5.90	5.95
Fixed Effects:								
Product × Borrower × Day	Yes		Yes		Yes		Yes	
Product × Borrower × Day × Lender		Yes		Yes		Yes		Yes

This table presents estimates of the heterogeneous green product characteristics along different maximum LTV ratios. The first six columns show the results for the residential sector. The last two columns refer to the buy-to-let segment. These estimates are based on the whole sample period (May/27/2022 to September/30/2023). Product types, included in the fixed effects, are defined as groups of products that share the same interest rate type (fixed or variable), the same initial interest rate fixation period, and the same maximum loan-to-value ratio. Borrower types refer to the categories of borrowers for which the product is available, including first-time buyers, second-time buyers, remortgagors and others. Products may be available to any combination of these four borrower types. We use the original classification of lenders provided by Moneyfacts. Appendix B provides a detailed description of the variables. Standard errors are clustered by lender. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 11. Customer Acquisition: Products Offered by Borrower Types

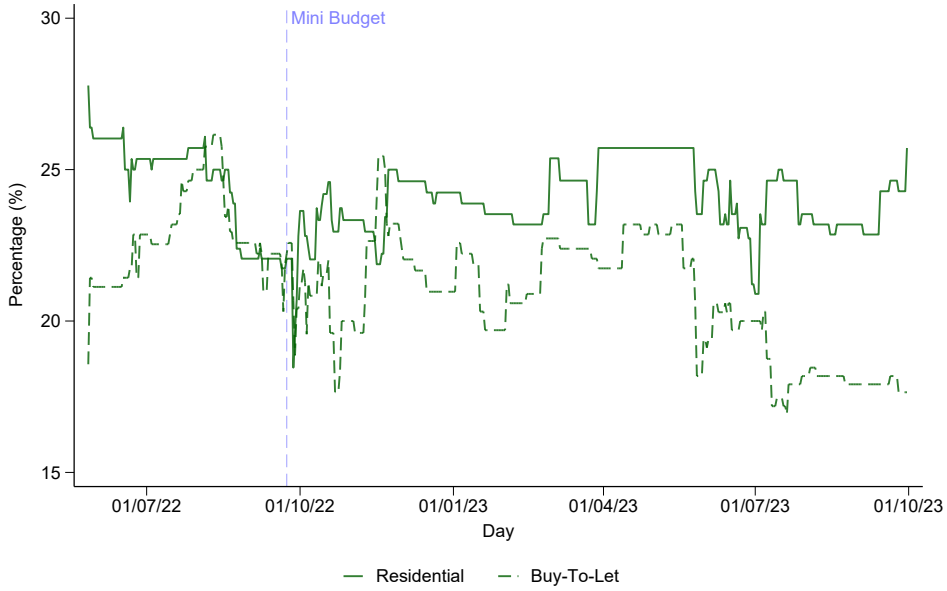
	Panel A: Residential					
Dependent Variable:	$\mathbb{1}_{\text{Buyers Only}}$			$\mathbb{1}_{\text{Available to Remortgagors}}$		
	(1)	(2)	(3)	(4)	(5)	(6)
Green	0.31***	0.22**	0.02	-0.23***	-0.10***	0.07*
	(0.10)	(0.10)	(0.03)	(0.07)	(0.04)	(0.04)
Cashback (Binary) [β_1]			-0.12			0.28***
			(0.13)			(0.10)
Green × Cashback (Binary) [β_2]			0.35***			-0.40***
			(0.12)			(0.10)
Constant	0.32***	0.34***	0.38***	0.60***	0.58***	0.50***
	(0.03)	(0.01)	(0.04)	(0.04)	(0.00)	(0.03)
Observations	2,802,916	2,681,817	2,681,817	2,802,916	2,681,817	2,681,817
Adjusted R-Squared	0.10	0.25	0.27	0.11	0.33	0.37
Mean Dep. Variable	0.36	0.37	0.37	0.57	0.57	0.57
P-value $\beta_1 + \beta_2$			0.03			0.02
Fixed Effects:						
Product × Day	Yes			Yes		
Product × Day × Lender		Yes	Yes		Yes	Yes

	Panel B: Buy-to-Let					
Dependent Variable:	$\mathbb{1}_{\text{Buyers Only}}$			$\mathbb{1}_{\text{Available to Remortgagors}}$		
	(1)	(2)	(3)	(4)	(5)	(6)
Green	0.03	0.10	0.07*	-0.03	-0.09	-0.05
	(0.07)	(0.08)	(0.04)	(0.07)	(0.08)	(0.04)
Cashback (Binary) [β_1]			-0.10			0.10
			(0.08)			(0.08)
Green × Cashback (Binary) [β_2]			0.16			-0.16
			(0.22)			(0.22)
Constant	0.14***	0.14***	0.15***	0.81***	0.82***	0.80***
	(0.03)	(0.01)	(0.02)	(0.03)	(0.01)	(0.02)
Observations	1,138,870	1,111,509	1,111,509	1,138,870	1,111,509	1,111,509
Adjusted R-Squared	0.11	0.35	0.35	0.11	0.34	0.34
Mean Dep. Variable	0.15	0.15	0.15	0.81	0.81	0.81
P-value $\beta_1 + \beta_2$			0.81			0.82
Fixed Effects:						
Product × Day	Yes			Yes		
Product × Day × Lender		Yes	Yes		Yes	Yes

This table presents estimates of the probability of green products being offered to different borrowers types, namely buyers only (columns (1)-(3)), and remortgagors (columns (4)-(6)). Panel A covers the residential segment, while Panel B refers to the Buy-to-Let segment. Columns (3) and (6) include the interaction terms with Cashback (Binary). These estimates are based on the whole sample period (May/27/2022 to September/30/2023). Product types, included in the fixed effects, are defined as groups of products that share the same interest rate type (fixed or variable), the same initial interest rate fixation period, and the same maximum loan-to-value ratio. We use the original classification of lenders provided by Moneyfacts. Appendix B provides a detailed description of the variables. Standard errors are clustered by lender. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

A Appendix: Figures and Tables

Figure A1. Daily Share of Lenders Offering Green Mortgages

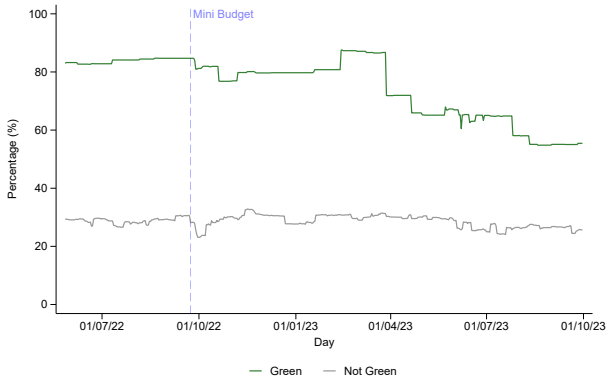


This figure shows the time-series of the share of lenders offering green mortgages, based on the consolidated lender classification. We distinguish between the residential and the buy-to-let segments. The vertical line identifies the mini-budget announcement of 23 September 2022. Appendix B provides a detailed description of the variables.

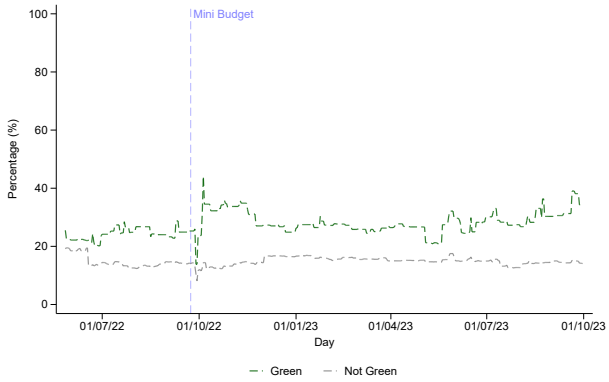
Figure A2. Time-series of Probability of Offering Cashback and Cashback Amount

Panel A: Probability of Cashback

(a) Residential

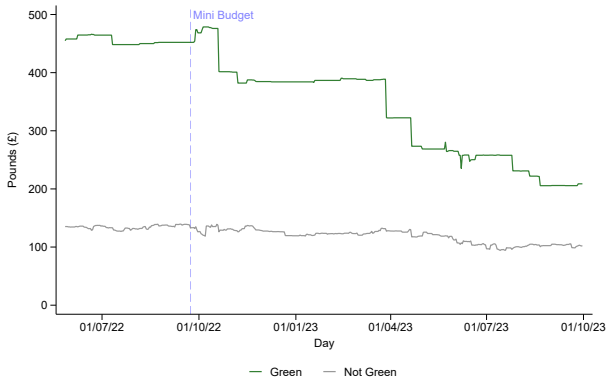


(b) Buy-to-Let

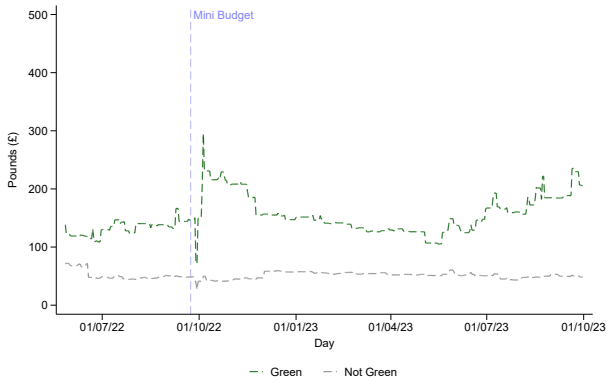


Panel B: Cashback Amount

(c) Residential

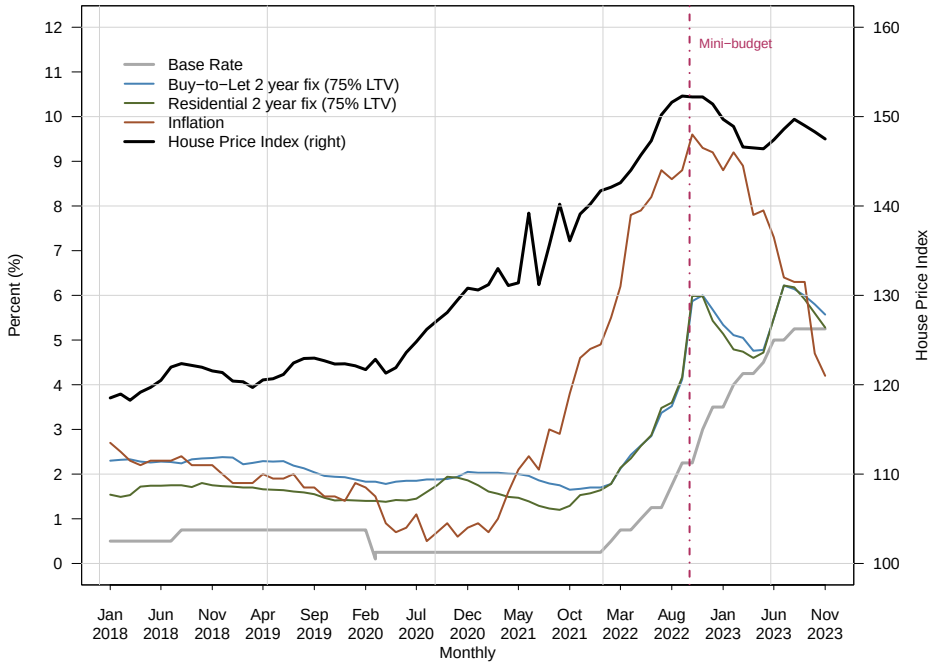


(d) Buy-to-Let



This figure shows the time-series of the share of products offering cashback (Panel A), and the average cashback amount (Panel B). Figures A2a and A2c refer to the residential market. Figure A2b and A2d refer to the buy-to-let market. The vertical line identifies the mini-budget announcement of 23 September 2022. Appendix B provides a detailed description of the variables.

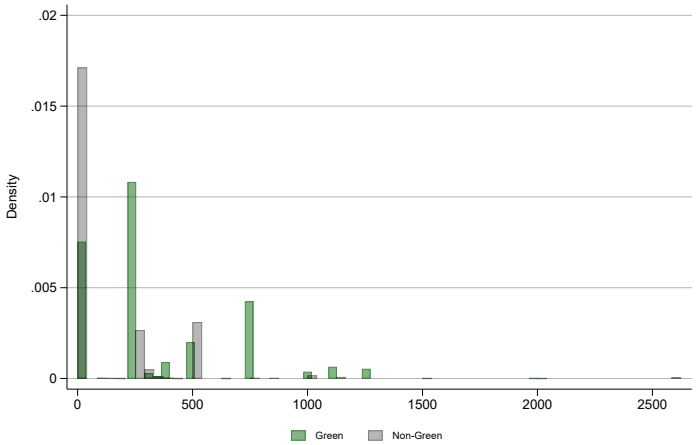
Figure A3. Mortgage Interest Rates, House Price Index and Inflation around Mini-Budget Announcement



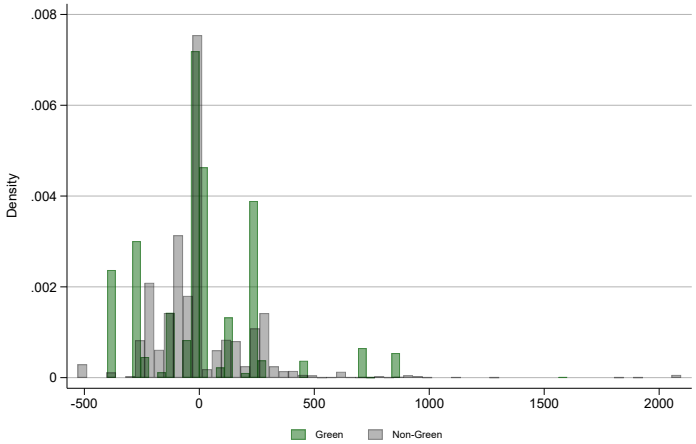
This figure shows the time-series of interest rates (Bank of England base rate, and both residential and buy-to-let 2-year fix rates for loans with 75% LTV ratio), inflation, and the house price inde (provided by the UK Land Registry). The vertical line identifies the mini-budget announcement.

Figure A4. Distribution of Cashback Amount in the Residential Segment

(a) Not residualized

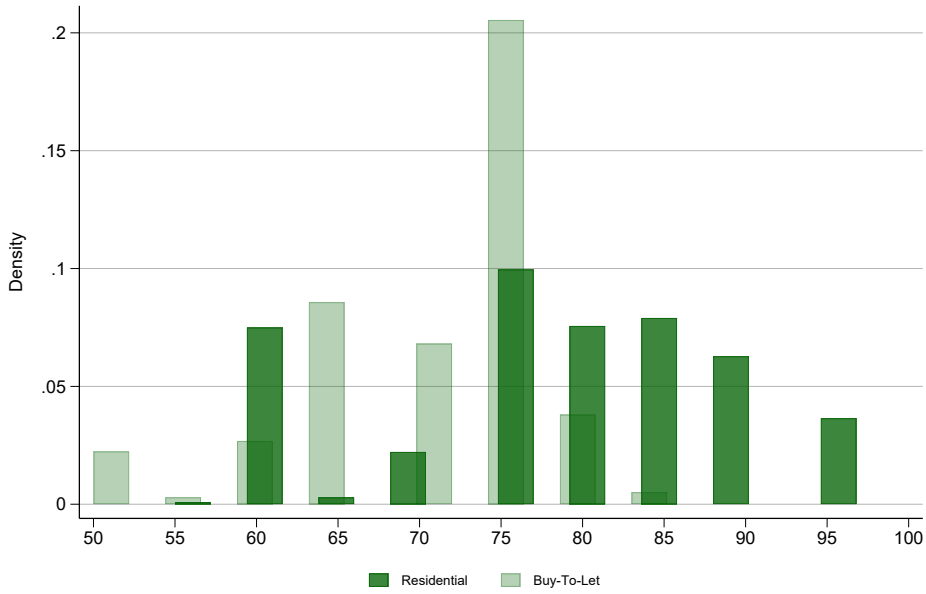


(b) Residualized by Lender Fixed Effects



This figure shows the distribution of cashback amount for the residential segment. Figure A4b shows the distribution of cashback amount after residualizing by lender fixed effects. Appendix B provides a detailed description of the variables.

Figure A5. Distribution of Maximum Product LTV for Green Products



This figure shows the distribution of the maximum product LTV for green products, both in the residential and in the buy-to-let segments. Appendix B provides a detailed description of the variables.

Table A1. Summary Statistics: Green Mortgages, by EPC Rating

	Panel A: Residential							
	EPC Rating: A or B ($n = 242,947$)				EPC Rating: A, B or C ($n = 98,566$)			
	Mean	Std. Dev.	p25	p75	Mean	Std. Dev.	p25	p75
Fixation Term (Years)	3.98	2.45	2.00	5.00	3.20	1.70	2.00	5.00
Maximum LTV Ratio (%)	78.62	11.25	75.00	85.00	77.88	9.11	70.00	85.00
Fixed Rate Mortgage (Binary)	0.90	0.30	1.00	1.00	0.89	0.31	1.00	1.00
Available to First Time Buyers (Binary)	0.64	0.48	0.00	1.00	0.78	0.41	1.00	1.00
Available to Second Time Buyers (Binary)	0.58	0.49	0.00	1.00	0.78	0.41	1.00	1.00
Available to Remortgagors (Binary)	0.24	0.42	0.00	0.00	0.64	0.48	0.00	1.00
Available to Other Borrowers (Binary)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Initial Rate (%)	5.03	1.01	4.37	5.79	5.80	1.36	4.61	6.84
Reversion Rate (%)	7.02	1.30	5.99	7.99	7.59	1.66	6.70	9.20
Cashback (Binary)	0.90	0.31	1.00	1.00	0.30	0.46	0.00	1.00
Cashback Amount (£)	361.64	239.19	250.00	500.00	234.94	423.08	0.00	400.00
Total Flat Fees (£)	525.59	519.88	0.00	999.00	519.81	531.78	0.00	995.00
Total Percent Fees (%)	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00
Stated Benefit (Green): Preferential Rate (Binary)	0.15	0.35	0.00	0.00	1.00	0.00	1.00	1.00
Stated Benefit (Green): Cashback (Binary)	0.94	0.24	1.00	1.00	0.30	0.46	0.00	1.00
Stated Benefit (Green): Reduced Fees (Binary)	0.00	0.00	0.00	0.00	0.02	0.14	0.00	0.00

	Panel B: Buy-to-Let							
	EPC Rating: A or B ($n = 26,692$)				EPC Rating: A, B or C ($n = 94,179$)			
	Mean	Std. Dev.	p25	p75	Mean	Std. Dev.	p25	p75
Fixation Term (Years)	3.66	1.49	2.00	5.00	4.10	1.90	2.00	5.00
Maximum LTV Ratio (%)	72.75	5.90	65.00	75.00	69.38	7.40	65.00	75.00
Fixed Rate Mortgage (Binary)	1.00	0.00	1.00	1.00	0.88	0.33	1.00	1.00
Available to First Time Buyers (Binary)	0.35	0.48	0.00	1.00	0.02	0.15	0.00	0.00
Available to Second Time Buyers (Binary)	0.72	0.45	0.00	1.00	0.81	0.39	1.00	1.00
Available to Remortgagors (Binary)	0.40	0.49	0.00	1.00	0.89	0.31	1.00	1.00
Available to Other Borrowers (Binary)	0.06	0.23	0.00	0.00	0.03	0.18	0.00	0.00
Initial Rate (%)	5.87	1.52	4.77	7.14	5.54	1.17	4.75	6.29
Reversion Rate (%)	6.99	1.31	6.00	8.00	7.69	1.55	6.24	9.09
Cashback (Binary)	0.35	0.48	0.00	1.00	0.18	0.38	0.00	0.00
Cashback Amount (£)	166.79	231.89	0.00	500.00	64.63	158.33	0.00	0.00
Total Flat Fees (£)	511.80	480.68	0.00	995.00	988.92	1,441.00	199.00	1,495.00
Total Percent Fees (%)	0.51	0.62	0.00	1.00	1.86	1.15	1.25	2.00
Stated Benefit (Green): Preferential Rate (Binary)	0.68	0.47	0.00	1.00	0.88	0.33	1.00	1.00
Stated Benefit (Green): Cashback (Binary)	0.32	0.47	0.00	1.00	0.01	0.11	0.00	0.00
Stated Benefit (Green): Reduced Fees (Binary)	0.00	0.00	0.00	0.00	0.08	0.27	0.00	0.00

This table shows summary statistics for the main variables used in the paper, focusing exclusively on green mortgage products. We show these statistics separately for the two main EPC rating requirements, as outlined in Table 2. These statistics are calculated using the full dataset at the product-day level. Panel A covers the residential segment, while Panel B refers to the Buy-to-Let segment. Appendix B provides a detailed description of the variables.

Table A2. Incentives: Cashback Amount Offered on Mortgages that Offer Cashback

Dependent Variable:	Cashback Amount (£)					
Segment:	Residential			Buy-to-Let		
	(1)	(2)	(3)	(4)	(5)	(6)
Green	39.17	24.56	111.97	194.24	229.12	315.43
	(59.28)	(78.27)	(114.92)	(129.44)	(156.70)	(221.41)
Constant	423.91***	427.74***	408.89***	349.38***	341.38***	322.50***
	(30.71)	(33.27)	(33.35)	(19.26)	(27.23)	(47.69)
Observations	952,232	943,951	843,933	183,820	177,937	157,405
Adjusted R-Squared	0.04	0.18	0.65	0.24	0.34	0.57
Mean Dep. Variable	434.26	434.28	441.38	386.02	386.01	390.43
Fixed Effects:						
Product × Day	Yes			Yes		
Product × Borrower × Day		Yes			Yes	
Product × Borrower × Day × Lender			Yes			Yes

This table presents estimates of the difference in the cashback amount between green and non-green products conditional on products offering cashback, based on the model specified in Equation 1. Columns (1)-(3) refer to the residential segment, while columns (4)-(6) refer to the buy-to-let market. These estimates are based on the whole sample period (May/27/2022 to September/30/2023). Product types, included in the fixed effects, are defined as groups of products that share the same interest rate type (fixed or variable), the same initial interest rate fixation period, and the same maximum loan-to-value ratio. Borrower types refer to the categories of borrowers for which the product is available, including first-time buyers, second-time buyers, remortgagors and others. Products may be available to any combination of these four borrower types. We use the original classification of lenders provided by Moneyfacts. Appendix B provides a detailed description of the variables. Standard errors are clustered by lender. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A3. Incentives: Cashback Offered on Mortgages in the Buy-to-Let Segment

Dependent Variable:	𝟙(Cashback)			Cashback Amount (£)		
	(1)	(2)	(3)	(4)	(5)	(6)
Green	0.13	0.10	0.09	100.52	95.48	109.33
	(0.11)	(0.09)	(0.08)	(85.49)	(86.58)	(98.96)
Constant	0.15***	0.15***	0.15***	51.37***	51.86***	49.02***
	(0.03)	(0.02)	(0.01)	(11.38)	(8.14)	(11.60)
Observations	1,138,870	1,126,318	1,062,067	1,138,786	1,126,259	1,062,067
Adjusted R-Squared	0.08	0.18	0.50	0.10	0.16	0.45
Mean Dep. Variable	0.16	0.16	0.16	62.78	62.81	61.84
Fixed Effects:						
Product × Day	Yes			Yes		
Product × Borrower × Day		Yes			Yes	
Product × Borrower × Day × Lender			Yes			Yes

This table presents estimates of the difference in cashback between green and non-green products, based on the model specified in Equation 1. The outcome variables are 𝟙(Cashback) (columns (1)-(3)) and Cashback Amount (£) (columns (4)-(6). These estimates refer to the buy-to-let segment and are based on the whole sample period (May/27/2022 to September/30/2023). Product types, included in the fixed effects, are defined as groups of products that share the same interest rate type (fixed or variable), the same initial interest rate fixation period, and the same maximum loan-to-value ratio. Borrower types refer to the categories of borrowers for which the product is available, including first-time buyers, second-time buyers, remortgagors and others. Products may be available to any combination of these four borrower types. We use the original classification of lenders provided by Moneyfacts. Appendix B provides a detailed description of the variables. Standard errors are clustered by lender. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A4. Incentives: Interest Rate on Products Offered, Based on Lender's Ultimate Ownership

	Green Products Stating "Preferential Rate" as a Benefit					
Dependent Variable:	Initial Rate (%)					
Segment:	Residential			Buy-to-Let		
	(1)	(2)	(3)	(4)	(5)	(6)
Green	-0.35	-0.35*	-0.09**	-0.36	-0.30	-0.13***
	(0.31)	(0.20)	(0.04)	(0.24)	(0.18)	(0.02)
Constant	5.53***	5.53***	5.55***	5.90***	5.91***	5.94***
	(0.18)	(0.14)	(0.00)	(0.19)	(0.16)	(0.00)
Observations	2,591,029	2,563,852	2,373,853	1,110,279	1,097,708	1,046,444
Adjusted R-Squared	0.53	0.64	0.94	0.53	0.62	0.94
Mean Dep. Variable	5.51	5.52	5.54	5.87	5.88	5.93
Fixed Effects:						
Product × Day	Yes			Yes		
Product × Borrower × Day		Yes			Yes	
Product × Borrower × Day × Financial Group			Yes			Yes

This table presents estimates of the difference in the initial rate between green and non-green products, based on the model specified in Equation 1. Columns (1)-(3) refer to the residential segment, while columns (4)-(6) refer to the buy-to-let market. These estimates are based on the whole sample period (May/27/2022 to September/30/2023). Product types, included in the fixed effects, are defined as groups of products that share the same interest rate type (fixed or variable), the same initial interest rate fixation period, and the same maximum loan-to-value ratio. Borrower types refer to the categories of borrowers for which the product is available, including first-time buyers, second-time buyers, remortgagors and others. Products may be available to any combination of these four borrower types. Appendix B provides a detailed description of the variables. Standard errors are clustered by financial group. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A5. Incentives: Cashback Offered on Mortgages in the Residential Segment, Based on Lender's Ultimate Ownership

	Green Products Stating "Cashback" as a Benefit					
Dependent Variable:	$\mathbb{1}$(Cashback)			Cashback Amount (£)		
	(1)	(2)	(3)	(4)	(5)	(6)
Green	0.62***	0.53***	0.51***	295.98***	241.76***	206.06***
	(0.07)	(0.10)	(0.14)	(63.27)	(48.45)	(48.88)
Constant	0.29***	0.30***	0.31***	123.20***	128.95***	136.04***
	(0.03)	(0.03)	(0.01)	(17.03)	(17.10)	(5.09)
Observations	2,718,053	2,691,805	2,497,826	2,717,949	2,691,701	2,497,806
Adjusted R-Squared	0.19	0.30	0.62	0.15	0.27	0.67
Mean Dep. Variable	0.35	0.35	0.36	151.74	152.49	157.51
Fixed Effects:						
Product × Day	Yes			Yes		
Product × Borrower × Day		Yes			Yes	
Product × Borrower × Day × Financial Group			Yes			Yes

This table presents estimates of the difference in the probability of cashback and the cashback amount between green and non-green products, based on the model specified in Equation 1. These estimates refer to the residential segment and are based on the whole sample period (May/27/2022 to September/30/2023). Product types, included in the fixed effects, are defined as groups of products that share the same interest rate type (fixed or variable), the same initial interest rate fixation period, and the same maximum loan-to-value ratio. Borrower types refer to the categories of borrowers for which the product is available, including first-time buyers, second-time buyers, remortgagors and others. Products may be available to any combination of these four borrower types. Appendix B provides a detailed description of the variables. Standard errors are clustered by financial group. Significance levels: * p < 0.10, ** p < 0.05, *** p < 0.01.

Table A6. Incentives: Fees Charged on Products Offered

Dependent Variable:	**Panel A:** Flat Fees (£)					
Segment:	Residential			Buy-to-Let		
	(1)	(2)	(3)	(4)	(5)	(6)
Green	-94.24	-43.22	28.04	-87.14	-73.21	-157.96
	(65.31)	(60.78)	(27.80)	(255.54)	(218.48)	(199.79)
Constant	625.24***	618.92***	611.47***	841.07***	833.47***	832.94***
	(26.82)	(22.94)	(3.75)	(56.76)	(46.37)	(22.25)
Observations	2,774,254	2,750,445	2,531,803	748,365	735,559	678,843
Adjusted R-Squared	0.04	0.08	0.22	0.08	0.12	0.32
Mean Dep. Variable	613.47	613.48	615.25	831.70	825.48	815.35
Fixed Effects:						
Product × Day	Yes			Yes		
Product × Borrower × Day		Yes			Yes	
Product × Borrower × Day × Lender			Yes			Yes

Dependent Variable:	**Panel B:** Percent Fees (%)					
Segment:	Residential			Buy-to-Let		
	(1)	(2)	(3)	(4)	(5)	(6)
Green	-0.01*	-0.01*	-0.00	-0.22	-0.13	-0.14
	(0.01)	(0.00)	(0.00)	(0.28)	(0.23)	(0.11)
Constant	0.02***	0.02***	0.01***	1.65***	1.66***	1.74***
	(0.01)	(0.01)	(0.00)	(0.13)	(0.08)	(0.02)
Observations	1,208,625	1,190,379	909,065	772,302	757,500	715,333
Adjusted R-Squared	0.20	0.25	0.97	0.21	0.35	0.62
Mean Dep. Variable	0.02	0.02	0.01	1.62	1.65	1.72
Fixed Effects:						
Product × Day	Yes			Yes		
Product × Borrower × Day		Yes			Yes	
Product × Borrower × Day × Lender			Yes			Yes

This table presents estimates of the difference in fess between green and non-green products, based on the model specified in Equation 1. The outcome variables are total flat fees (Panel A) and total percent fees (Panel B). For both panels, columns (1)-(3) refer to the residential segment, while columns (4)-(6) refer to the buy-to-let market. These estimates are based on the whole sample period (May/27/2022 to September/30/2023). Product types, included in the fixed effects, are defined as groups of products that share the same interest rate type (fixed or variable), the same initial interest rate fixation period, and the same maximum loan-to-value ratio. Borrower types refer to the categories of borrowers for which the product is available, including first-time buyers, second-time buyers, remortgagors and others. Products may be available to any combination of these four borrower types. We use the original classification of lenders provided by Moneyfacts. Appendix B provides a detailed description of the variables. Standard errors are clustered by lender. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A7. Incentives: Reversion Rate on Products Offered

Dependent Variable:	Reversion Rate (%)					
Segment:	Residential			Buy-to-Let		
	(1)	(2)	(3)	(4)	(5)	(6)
Green	0.07	0.14	-0.00	-0.00	0.06	-0.02*
	(0.14)	(0.10)	(0.00)	(0.15)	(0.13)	(0.01)
Constant	6.89***	6.88***	6.94***	7.55***	7.55***	7.59***
	(0.10)	(0.08)	(0.00)	(0.10)	(0.09)	(0.00)
Observations	2,662,324	2,638,494	2,428,978	1,071,034	1,060,557	998,881
Adjusted R-Squared	0.74	0.78	0.99	0.64	0.73	0.98
Mean Dep. Variable	6.90	6.90	6.94	7.55	7.56	7.59
Fixed Effects:						
Product × Day	Yes			Yes		
Product × Borrower × Day		Yes			Yes	
Product × Borrower × Day × Lender			Yes			Yes

This table presents estimates of the difference in the reversion rate between green and non-green products, based on the model specified in Equation 1. Columns (1)-(3) refer to the residential segment, while columns (4)-(6) refer to the buy-to-let market. These estimates are based on the whole sample period (May/27/2022 to September/30/2023). Product types, included in the fixed effects, are defined as groups of products that share the same interest rate type (fixed or variable), the same initial interest rate fixation period, and the same maximum loan-to-value ratio. Borrower types refer to the categories of borrowers for which the product is available, including first-time buyers, second-time buyers, remortgagors and others. Products may be available to any combination of these four borrower types. We use the original classification of lenders provided by Moneyfacts. Appendix B provides a detailed description of the variables. Standard errors are clustered by lender. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

B Appendix: Data Construction and Variable Definitions

As explained in Section 2.3, our data comes from Moneyfacts Group plc, an independent provider that collects daily information on mortgage products *on offer* in the UK. This dataset includes comprehensive information on mortgage products, comprising various numerical variables along with textual descriptions detailing product requirements, characteristics, and incentives. In this appendix section, we provide a detailed explanation of the variables used in our analysis and carefully describe the process of extracting numerical information from textual variables.

B.1 Data cleaning

Our sample period ranges from May 27, 2022 to September 30, 2023. The starting date is the day in which the green information (the green status and associated qualifying criteria and benefits) was added to the data. The main independent variable in our analysis is Green_i, which equals 1 for green mortgages and 0 otherwise. Given its importance, we carefully verify if it correctly captures green mortgages. Three major lenders in our sample — Lloyds Bank, Halifax, and Nationwide Building Society (BS) — offer cashback rewards on top of other product incentives, for properties eligible for a green mortgage. The product descriptions specify the criteria and corresponding rewards:

1. Lloyds Bank: "Green Home cashback for properties with an Energy Efficiency Band of A or B or a rating of 81 or higher £250. "
2. Halifax: "Green Home cashback for properties with an Energy Efficiency Band of A or B or a rating of 81 or higher £250. "
3. Nationwide BS: "Green reward for properties with an EPC score of 86 to 91 £250 or Green reward for properties with an EPC score of 92+ £500."

These green rewards are offered to qualifying mortgages on top of the other incentives for the non-qualifying (non-green) mortgages. However, for these lenders and products explicitly listing these incentives, Moneyfacts categorizes them only as green, without recording the non-green counterparts. To address this, we construct the non-green counterparts — identical products excluding the green cashback reward. For Nationwide BS (example 3), we assume a green reward of £250, as properties with an EPC score of 92+ make up a small proportion of the UK housing stock.

B.2 Variables

Table B1 below presents descriptions of the variables used in our analysis that did not require processing or extraction from textual sources. These variables are either numerical (recorded as such in the original dataset) or simple indicator or categorical variables.

Table B1. Variable Definitions

Variable	Description
Lender	Lender name and associated Moneyfacts company identifier
Product	Product name and associated unique Moneyfacts product identifier
Mortgage Type	Type of mortgage product: Residential or Buy-to-Let
Fixation Term	Number of years for the initial rate
Maximum LTV Ratio	Product maximum Loan-To-Value (LTV) ratio
Fixed Rate Mortgage	Indicator variable for fixed rate mortgages
Available to First Time Buyers	Indicator variable for products available to first time buyers
Available to Second Time Buyers	Indicator variable for products available to second time buyers
Available to Buyers Only	Indicator variable for products exclusively available to buyers, including first-time buyers, second-time buyers, or both
Available to Remortgagors	Indicator variable for products available to remortgagors
Available to Other Borrowers	Indicator variable for products available to other borrowers
Initial Rate	Interest rate charged for the initial period of the mortgage (fixation period)
Reversion Rate	Interest rate charged for the remainder of the mortgage (after the fixation period, if the borrower does not refinance the mortgage)
$\mathbb{1}$(Cashback)	Indicator variable for products that offer cashback

Many key variables in our analysis are extracted from textual data. In the remainder of this section, we describe the original data provided by Moneyfacts and the extraction process for each variable. After extracting the information from the textual variables, we manually check the outcome of the extraction process to assure its accuracy.

B.2.1 Requirements for Green Mortgages and Stated Benefits

As a central focus of our analysis is to understand the requirements for green mortgages and the associated financial benefits outlined by lenders. This information is compiled by Moneyfacts in the "Green Description" variable, that provides a textual description of the green product.

B.2.2 EPC Rating

We begin by extracting information regarding the property's EPC rating requirements for a mortgage to be classified as green. The "Green Description" provides this information for virtually all the green mortgages, under different forms. Below, we provide examples of the green description of three different products:

- Example 1: "Preferential rate for the purchase or remortgage of a property with an EPC rating of A-C."
- Example 2: "Cashback for the purchase of a property with an EPC of A or B."

- Example 3: "Cashback for the purchase or remortgage of a property when the energy efficiency rating is improved by 10 or more SAP points within 12 months of completion."

We classify the EPC rating requirement of each green product into the four categories we identify across all green products: (i) A; (ii) A or B; (iii) A, B or C, (iv) E or Above. For example, a product's EPC rating is classified as "A or B" if the green description contains "A or B" or equivalents such as "minimum of B" or "B and above". We follow this procedure for all green products, which allows us to map the EPC requirements for the vast majority (over 97%) of products on offer. In example 1, the EPC requirement is "A, B, or C," while in Example 2, it is "A or B." In Example 3, we cannot identify the required EPC rating (not reported).

We also classify each product based on whether it targets properties with a current required EPC rating or if it allows for future energy improvements. Products are classified as targeting a current EPC rating if their green description refers to a "property with an EPC"(or equivalents such as "property must have an EPC"), which is the case of examples 1 and 2. Alternatively, products are classified as allowing for energy efficiency improvements if their green description contains terms such as "improving", "upgrade" or "renovation", as in example 3.

B.2.3 Stated benefits

We extract information on the stated product benefits from the green description. We identify three types of benefits: (i) preferential rate if the green description contains "preferential rate" or "rate reduction", such as example 1; (ii) cashback if the green description contains "cashback" or "cash payments", such as examples 2 and 3; (iii) reduced fees if the green description contains "reduced fees". Products can fall into multiple categories if they reference more than one benefit. We are able to extract this information for over 98% of the products.

We identified some green products that state offering cashback, but the original cashback variable - $\mathbb{1}$(Cashback) in Table B1 - is recorded as zero. These cases corresponds to around 84,000 green observations, and fall into 3 types of "Green Descriptions": (i) products that state cashback only (around 39,000 observations); (ii) products that preferential rate *and* cashback (around 16,000 observations); (iii) products that state preferential rate *and/or* cashback (around 29,000 observations). We replaced the original cashback variable by one for the observations in the first case, as these observations explicitly state they offer cashback in the green description. For the products in the second case, we record them as stating both preferential rate and cashback. For the products in the third case, it is unclear if they offer cashback only, preferential rate only, or both. We adopt a conservative approach and record them as not stating cashback if the original cashback variable takes the value of zero. All the other products in this case remain recorded as offering both preferential rate and cashback.

B.2.4 Financial Incentives: Cashback Amount

We extract the cashback amount for the variable "Incentives" provided by Monyefacts. This variable provides a textual description of all the incentives offered on the product, including cashback and waived fees. For example, one entry in this variable states: "Free valuation fees. No arrangement fees. £400 cashback On Completion". As we want to retrieve the cashback amount only, we focus on the part of the text that mentions cashback, and we extract the corresponding pound (£) amount (£400

in the example). Products may offer cashback exclusively to specific types of borrowers or provide different cashback amounts for different borrower types. In such cases, we extract the cashback amount separately for each borrower type and consider the mean across all types.[1] Finally, we replace the cashback amount by zero if the variable "Cashback" (described in Table B1) takes the value of zero.

B.2.5 Product Fees

We extract product fees from two variables: "Product Flat Fees", which specifies the amount in pounds, and "Product Percent Fees", which provides the fees as a percentage of the loan amount. Almost all products report either flat fees or percentage fees. There are three different types of fees: (i) completion fees; (ii) booking fees; (iii) arrangement fees. A product may report one or more types of fees, as illustrated in the following examples: "Arrangement £500 ; Booking £699" or "Completion £495". For both flat and percentage fees, we extract each product's reported completion, booking, and arrangement fees, and then calculate the total fees as the sum of these three types. Finally, we set the total fees (both flat and percentage) to zero if the product states "No additional fees".

Table B2 below presents descriptions of the variables that we extracted from textual sources as described before.

Table B2. Variable Definitions (Continued)

Variable	Description
EPC Rating	EPC rating requirement for green product
Current EPC	Green product offered based on property's current EPC rating
Improving EPC	Green product offered for property's EPC rating improvement
Stated Benefit (Green): Preferential Rate	Product's green description states that the product offers a preferential rate
Stated Benefit (Green): Cashback	Product's green description states that the product offers cashback
Stated Benefit (Green): Reduced Fees	Product's green description states that the product offers reduced fees
Cashback Amount	Cashback amount
Flat Fees	Total fees (completion, booking and arrangement) in pounds
Percent Fees	Total fees (completion, booking and arrangement) in percentage of loan amount

B.2.6 Lenders

Lender Classification. We use the lender names provided by Moneyfacts to classify lenders into four categories: (i) the top seven mortgage lenders; (2) banks; (iii) building societies; (iv) others. We identify the largest seven mortgage lenders from the annual ranking of mortgage lenders by outstanding

[1] In some cases, the cashback depends on the mortgage advance made by the borrower, such as in the following example: "£250 cashback £30K - £74999 of Mortgage Advance; £400 cashback Min £75K of Mortgage Advance". In these cases, we consider the midpoint (£325 in this case).

balances provided by the UK Finance Association.[2] We distinguish between banks and building societies primarily using the lender names provided by Moneyfacts, which include terms such as "Bank" or "Building Society" for most lenders. We manually verify and supplement this classification by searching each lender name and organization type online. The "Others" category primarily consists of lending companies (shadow banks).

Brands and Subsidiaries. We construct a consolidated lender identification variable based on the ultimate ownership of brands or subsidiaries as originally reported by Moneyfacts. For each lender in our original dataset, we manually identify their parent company and assign the lender to this parent company if it corresponds to a brand or subsidiary under its ownership. For instance, under this new variable, Birmingham Midshires Solutions is assigned the lender name and identifier of Lloyds Bank, as it is one of its brands. We primarily extract this information from the "Brands" page of major lenders in the UK or from the websites of the individual lenders as originally reported by Moneyfacts.[3]

[2]UK Finance is an association that represents the banking and finance industry in the UK (UK Largest Mortgage Lenders).

[3]Example from Lloyds Bank: Brands webpage.