Refinancing Cross-Subsidies in the UK Mortgage Market

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Motivation

- Household finance markets are characterized by considerable variation in financial sophistication (Campbell, 2006, Gomes et al., 2021).

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- Potential implications: Design of financial system, mortgage market, can amplify inequality (Campbell et al, 2019, Greenwald et al., 2021).

This Paper

- Studies mortgage refinancing using rich and granular administrative data in the U.K. on the total outstanding stock of mortgages.
  - Initially fixed "discounted" rates automatically rolled to high "revert" rate.
  - Prompt refinancers and sluggish refinancers suggests presence of cross-subsidies.
- Builds a partial equilibrium model of the UK mortgage market with heterogeneity in refinancing costs and heterogeneous valuations for housing.
- Structurally estimates model parameters, matching moments in the data.
- Uses parameters to assess size of cross-subsidy using counterfactual single-rate market design.
- Documents how cross-subsidies vary across income groups and areas of the U.K., shows evidence that they are regressive.

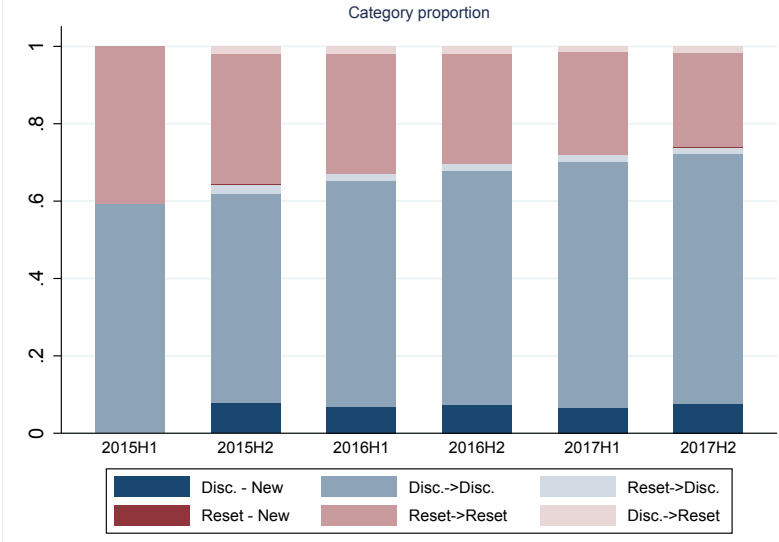
Data and Institutional Framework

Data

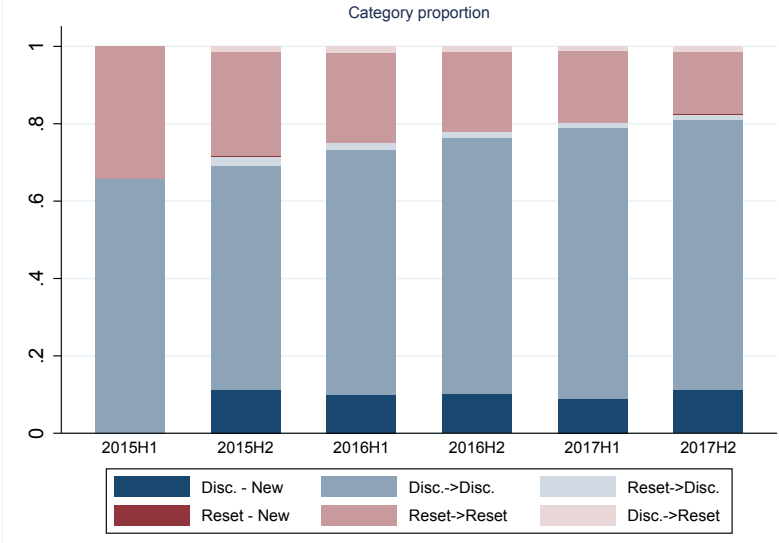
- Data sourced from the Financial Conduct Authority (Dataset PSD: 007).
  - Tracks stock of all outstanding loans issued by regulated financial institutions in the U.K. at a semi-annual frequency.
  - Data from June 2015—December 2017, we mainly utilize stock at June 2015 (2015H1) in this draft.
  - Eliminate buy-to-let and tracker mortgages, focus on discounted and revert rate mortgages. £566BN total stock in 2015H1.
  - Granular mortgage details, tracked over time, limited borrower characteristics (age, income).
  - Used in a range of studies (Cloyne et al., 2019, Robles-Garcia, 2019, Benetton, 2021).

- Borrower chooses initial fixation period with discounted "teaser" rate (modal value 2 years), automatically resets to higher reset rate on expiration unless refinanced.

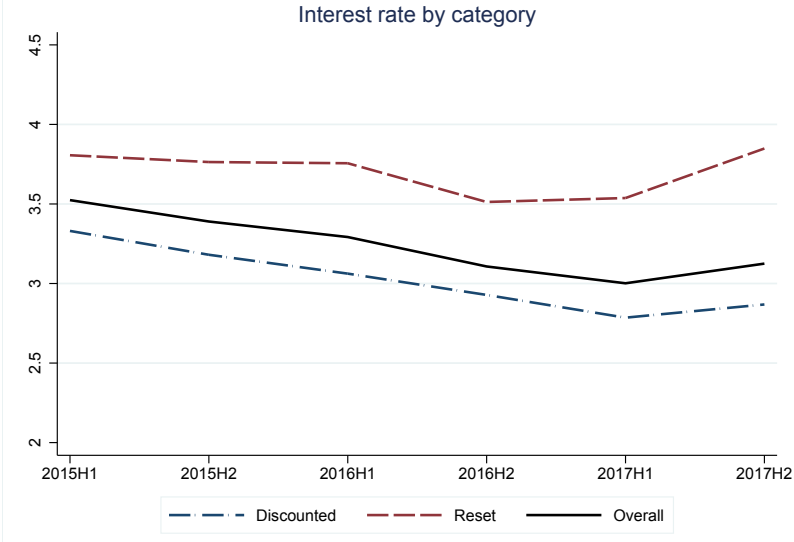
Fraction of Mortgages on Discounted and Reset Rates



Fraction of Mortgage Stock on Discounted and Reset Rates



Interest Rates in Different Categories



Summary Statistics: 2015H1

- We estimate cross-subsidies in the steady-state of our model, which we map to 2015H1 in this draft of the paper. (To extend in future versions).
- 2015H1 has highest share of reset rate mortgages. However, rate spread between discounted and reset rate is lowest in this period.

	mean	sd	p10	p25	p50	p75	p90
Balance (GBP)	121,808	98,542	36,236	63,090	100,465	151,508	222,382
Interest rate (in pp)	3.52	1.01	2.39	2.54	3.49	4.19	4.78
Spread to T-bill (in pp)	2.87	1.08	1.68	2.05	2.64	3.55	4.30
Original size (GBP)	134,115	100,495	50,000	75,000	112,000	162,999	235,548
Orig. term (in months)	273	152	144	216	288	324	396
Rem. term (in months)	218	97	88	149	213	285	350
Rem. discounted period	25	18	5	12	22	37	51
Borrower age	43.11	10.55	30.00	35.00	42.00	50.00	57.00

An Outline of the Model

Model: Assumptions

- Households differ along two dimensions:
  1. Their per-period valuation v for a house.
  2. The fixed cost k that they pay each time they refinance. (Jointly distributed with cdf $G(v,k)$, pdf $g(v,k)$. v,k assumed independent in this draft.)

- Household flow utility: $v(\omega l_0)^\alpha - m(\cdot)$ where ω is $\frac{1}{LTV}$ (LTV fixed, same for all households) and $m(\cdot)$ is mortgage payment.

- Households choose:
  - Loan size l_0.
  - Whether to refinance at each opportunity (model structure: T_{max} characterizes refinancing).

- Mortgages:
  - T periods, amortizing;
  - Interest rate r for initial T_d periods;
  - Reset rate $R > r$ after T_d periods if household does not refinance.

Model: Household value function

- Utility at origination equals

$$V(v,k,l_0,T_{max}) = \max_{T_{max}} \sum_{t=0}^{t=+\infty} \beta^t v\,(\omega l_0)^\alpha - \sum_{t=1}^{t=T_{max}} \beta^t m(l_0,r,T)$$
$$- k \sum_{t=1}^{T_{max}/T_d+1} \beta^{tT_d+1} - \sum_{t=T_{max}+1}^{t=T} \beta^t m(l_{T_{max}}(r,l_0),R,T-T_{max}).$$

- T_{max}: last period on discount rate.
  - Since the loan is amortizing, the incentives to refinance decline over time.
  - Households always refinance before T_{max}, and never refinance after T_{max}.
  - T_{max} is heterogeneous across households, and depends on their cost k and valuation v (through the initial loan size choice l_0).

- l_0: initial loan size trades off MB of larger housing (function of v) against MC of larger loan (function of T_{max} and v).

Model: Solution

- Solving the model means finding the optimal l_0 and the optimal T_{max} for each household, expressed in terms of the primitives v and k.
- Optimal loan size l_0 depends directly on v, and indirectly on k, through T_{max}, which determines the share of payments paid on each rate.
  - Rewrite l_0 in terms of T_{max} and v.
- At each l_0, we solve for T_{max} in terms of k using backward induction.
- Intuition: Set value of refinancing at a given opportunity τ equal to value of not refinancing. This allows us to solve for threshold $k^*(\tau)$.
  - All households with k below $k^*(\tau)$ refinance and all households with k above $k^*(\tau)$ do not; solve for all τ.
- In practice: $\max_{T_{max}} V(v, k, l_0(T_{max}), T_{max})$.

Model: Aggregation and the Stock of Mortgages

- Define three groups (i) of mortgages, and derive the aggregate number $N_i(\cdot)$ and aggregate balance $Q_i(\cdot)$ of mortgages in each group *in steady state*.
- Group 0: households with initial loan size $l_0(v, k)$ on their initial discounted rate.
  - Number $N_0(r)$ and quantity $Q_0(r)$ of these mortgages just adds all initial home buyers (those with valuation v above rental outside option).
- Group 1: Mortgages of households who refinanced into paying the discounted rate.
  - Number $N_1(r)$ and quantity $Q_1(r)$ of these mortgages just adds all refinancers (those with k below k^* in each cohort observed in steady state, satisfying v condition).
- Group 2: Mortgages of households who did not refinance, and pay the reset rate.
  - Number $N_2(R)$ and quantity $Q_2(R)$ of these mortgages just adds all reset rate payers (those with k above k^* in each cohort observed in steady state, satisfying v condition).

Model: Computing Cross-Subsidies

- Consider a counterfactual in which all households pay a single constant interest rate r_f, meaning no refinancing ($T_{max} = T$), and optimal loan size is $l_0(v, k) = l_0(v, 0)$.
- We can compute r_f by equating revenues in the two worlds:

$$r_f Q(r_f) = r(Q_0(r) + Q_1(r)) + RQ_2(R).$$

- We can also apply the model to groups $j = 1, \ldots, J$ of households, i.e.:

$$r_f \sum_{j=1}^{J} Q_j(r_f) = \sum_{j=1}^{J} r(Q_{0j}(r) + Q_{1j}(r)) + RQ_{2j}(R),$$

which can be used to calculate group-specific (e.g., income, region) cross-subsidies.

Structural Estimation

Calibrated Parameters

- Top part of panel shows parameters taken from the data or set; bottom shows estimated parameters (predicted and data moments coming up).

r	3.331	R	3.806
T	30	T_d	2
β	0.950	ω	1.250
η	0.500		
μ_v	-0.574	σ_v	0.115
μ_{k_1}	4.761	σ_{k_1}	0.645
μ_{k_2}	8.536	σ_{k_2}	0.410
$\bar{u}$	1,413	M	271,537
α	0.784		

Model Fit

	Data	Model
Mean Loan Balance, Discounted Rate	135,045	148,316
Standard Deviation Loan Balance, Discounted Rate	106,510	95,919
Mean Loan Balance, Reset Rate	102,506	112,155
Standard Deviation Loan Balance, Reset Rate	81,853	72,364
Mean Remaining Years, Discounted Rate	19.87	16.63
Standard Deviation Remaining Years, Discounted Rate	8.10	8.77
Mean Remaining Years, Reset Rate	15.74	13.99
Standard Deviation Remaining Years, Reset Rate	7.38	8.26
Share of Mortgages on Discounted Rate, 0-5 Percentile	31.69	31.24
Share of Mortgages on Discounted Rate, 5-25 Percentile	51.40	50.24
Share of Mortgages on Discounted Rate, 25-50 Percentile	56.21	50.67
Share of Mortgages on Discounted Rate, 50-75 Percentile	62.44	60.20
Share of Mortgages on Discounted Rate, 75-95 Percentile	69.44	68.81
Share of Mortgages on Discounted Rate, 95-100 Percentile	78.10	80.96
Number of Mortgages on Discounted Rate	2,752,800	2,679,638
Number of Mortgages on Reset Rate	1,887,844	2,010,082
Share of Owners	63.13	57.57

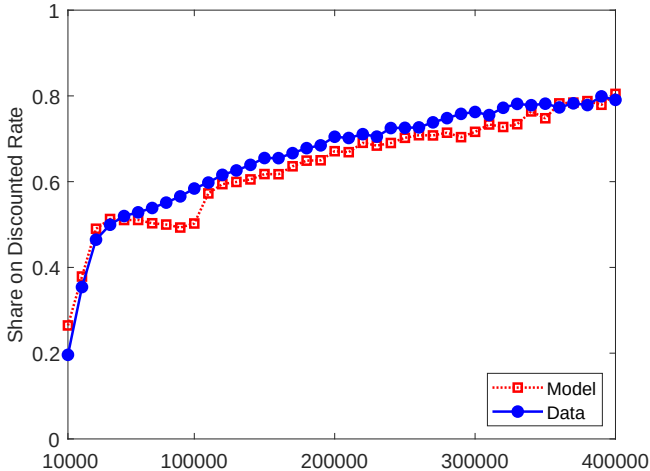
Calibrated Parameters: Magnitudes

- Valuation v for housing and concave utility from housing ($\alpha = 0.78$) implies annual average consumption flow utility of £5,647 from house worth £125,000, roughly 4.5% of house value p.a.

- Average refinancing cost estimated to equal £2,842, sd. of £3,143 across all households; two groups modelled in our setup (high-cost (£5,539) and low-cost (£144) households).

- Magnitudes higher than Andersen et al., 2020 estimated in Denmark (roughly £1852), but plausible given different mechanisms in the two approaches.

Share of Loans on Discounted Rate: Mixture of Lognormals



Notes: This figure displays the share of loans paying the discounted rate as a function of its loan balance in the data (solid line) and in the model evaluated at the calibrated parameters (dashed line).

Cross-Subsidies and How They are Distributed

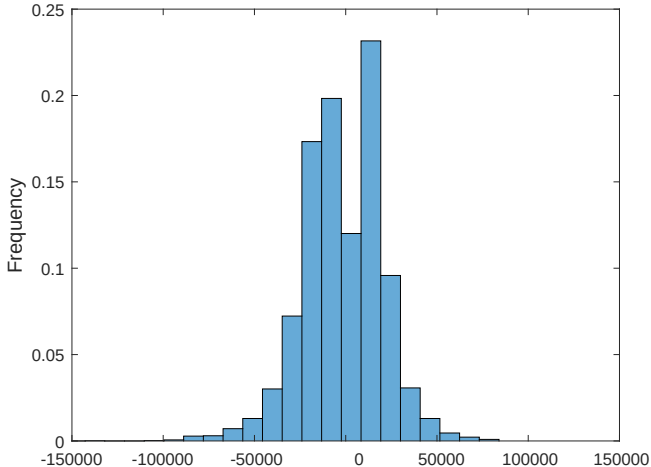
Interest Rates and Loan Sizes, Single Group

- Use the estimated model parameters and equate revenues to predict counterfactual single-rate world.
- Changes to mortgage takeup and size; re-optimized under new rates.

	Model	Counterfactual
Discounted Rate	3.33	3.54
Reset Rate	3.81	3.54
Mean Initial Loan Amount	221,055	215,253
Standard Deviation Initial Loan Amount	95,371	89,042
Mean Loan Balance	132,817	129,562
Standard Deviation Loan Balance	88,440	84,596
Number of Mortgages	4,689,720	4,767,922

Notes: This table reports the statistics on the mortgage market in the baseline model and in a counterfactual market with constant interest rates.

Changes in Mortgage Size Depend on Household Refinancing Costs



Notes: This figure reports the distribution of the changes in loan sizes between the counterfactual market with constant interest rates and the baseline case with discounted and reset rates.

Mechanisms Underlying Cross-Subsidy Calculations

- Cross-subsidy calculation compares outcomes in single- and dual-rate worlds.
- Affected by *two* household attributes:
  - k: Fixed cost of refinancing.
  - v: Affects l_0 (as does k)—benefit from refinancing (R, r path vs. rf scaled by l_0).

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- v effect more complex, affected by choice (leverage, risk-tolerance), and constraints (downpayment, wealth, income). In data:
  - l_0 strongly correlates with regional socio-economic status, over and above employment, LTV, and region FEs.
  - Suggests v correlation with constraints, since k *negatively* related to l_0 in the model (high k borrowers internalize).
- Caveat: v and k independent within groups (though we find, negatively correlated across groups). Conservative.

Cross-Subsidies Across Income and Regional Groups

- We re-estimate the model for a set of subgroups of the data:
  - 12 income groups (10 deciles of income, with top decile further subdivided into two groups).
  - 12 administrative regions of the U.K.
- Using group-specific parameters, calculate:
  - Average interest rate change for each group.
  - Average loan balance change...
  - Average annual payment change...
- There is considerable *within-group* variation in the data, but in this exercise, calculate *across-group* distribution of cross-subsidies.
- Show selected descriptive statistics of these groups in each case to provide intuition about where cross-subsidies are coming from.

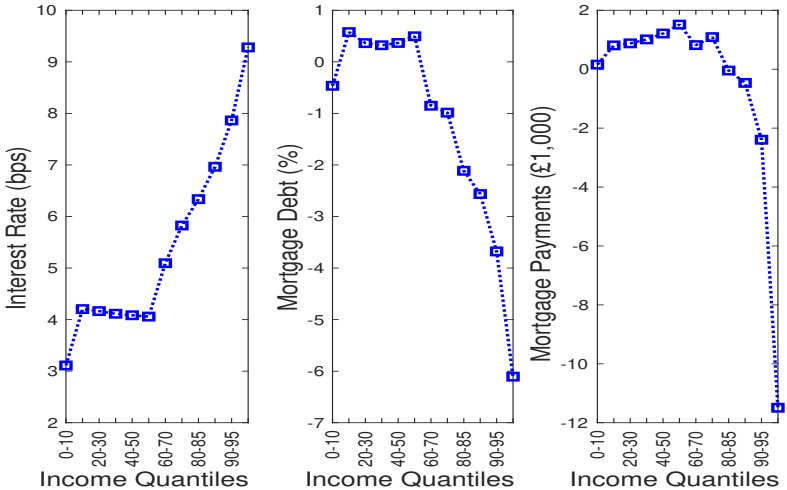
Descriptive Statistics, Income Groups

Table: Aggregate moments (means), by inc. quantiles

	Inc. level	Prop. (Disc.)	Disc. rate	Reset rate	Bal.
0-10	23,889	0.60	3.46	3.98	52,467
10-20	29,933	0.60	3.46	3.92	70,577
20-30	35,098	0.60	3.45	3.90	82,615
30-40	40,187	0.60	3.42	3.86	93,053
40-50	45,661	0.60	3.38	3.82	104,007
50-60	52,100	0.61	3.35	3.79	115,834
60-70	60,387	0.61	3.31	3.76	130,480
70-80	72,639	0.63	3.25	3.72	150,128
80-85	81,902	0.64	3.19	3.70	171,718
85-90	96,303	0.64	3.13	3.69	194,137
90-95	126,227	0.66	3.04	3.66	232,089
95-100	214,948	0.67	2.89	3.58	353,477

Cross-Subsidies Across Income Groups

Adjustments to mortgage debt offset higher interest rates; lower mortgage payments in some high income groups.



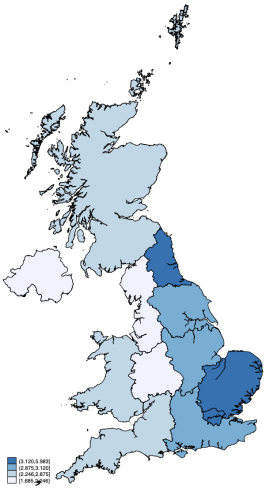
Descriptive Statistics, U.K. Regions and Devolved Administrations

Table: Aggregate moments (means), by administrative regions

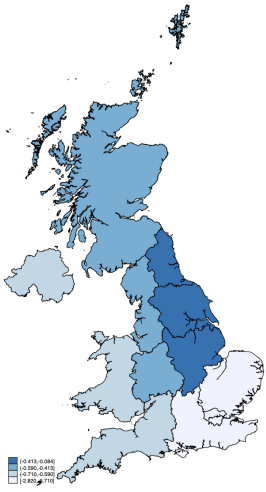
	Prop. (Disc.)	Disc. rate	Reset rate	Bal.
Northern Ireland	0.46	3.47	4.08	89,511
North East (England)	0.53	3.51	3.86	86,579
Scotland	0.55	3.42	3.88	93,701
Wales	0.55	3.45	3.82	92,518
North West (England)	0.56	3.47	3.88	96,186
West Midlands (England)	0.56	3.41	3.70	102,642
Yorkshire and The Humber	0.57	3.46	3.91	93,630
East Midlands (England)	0.58	3.44	3.74	99,211
South West (England)	0.62	3.32	3.64	122,390
East of England	0.64	3.27	3.76	137,649
London	0.65	3.02	3.86	199,898
South East (England)	0.65	3.21	3.69	156,979

Regional Changes

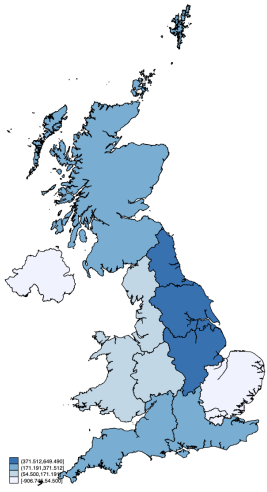
Interest rates higher under counterfactual in relatively wealthier U.K. administrative regions.



(a) Interest Rate



(b) Mortgage Debt



(c) Mortgage Payments

Conclusion

- Structural estimation of refinancing cross-subsidies in the U.K. mortgage market.
- Match broad features of the data, with realistic parameters that highlight significant cross-household variation in refinancing costs.
- Quantification of cross-subsidies shows that rates in the counterfactual single-rate equilibrium lie 20bp above discounted rate, but 30 bp below reset rate on average.
- Changes are unevenly distributed across the U.K., with higher income groups and wealthier regions seeing bigger increases in rates than poorer groups/regions.
- Endogenous response to rate changes mean that mortgage payments (and takeup) grow more for poorer groups/regions, and shrink for richer groups/regions. "Democratization" of mortgage takeup.