Energy efficiency vs. default probability

Nationwide Building Society

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29 March 2021

Who is Nationwide Building Society

UK retail "bank" (building society)
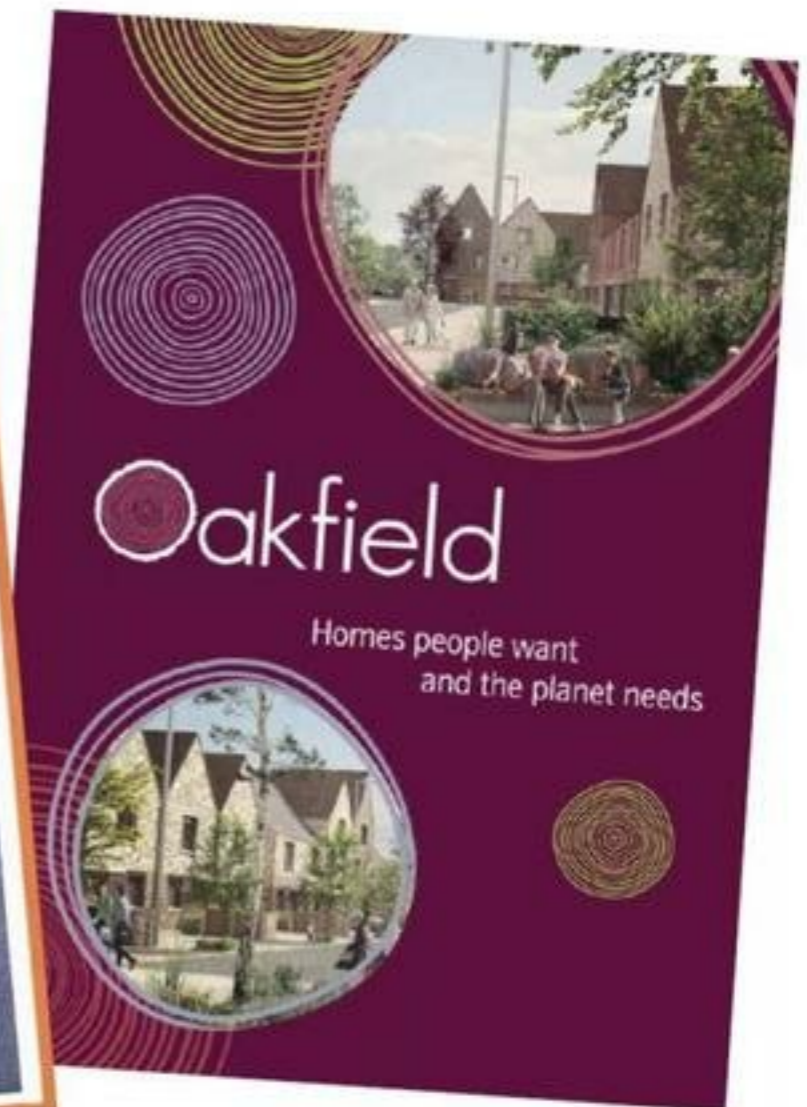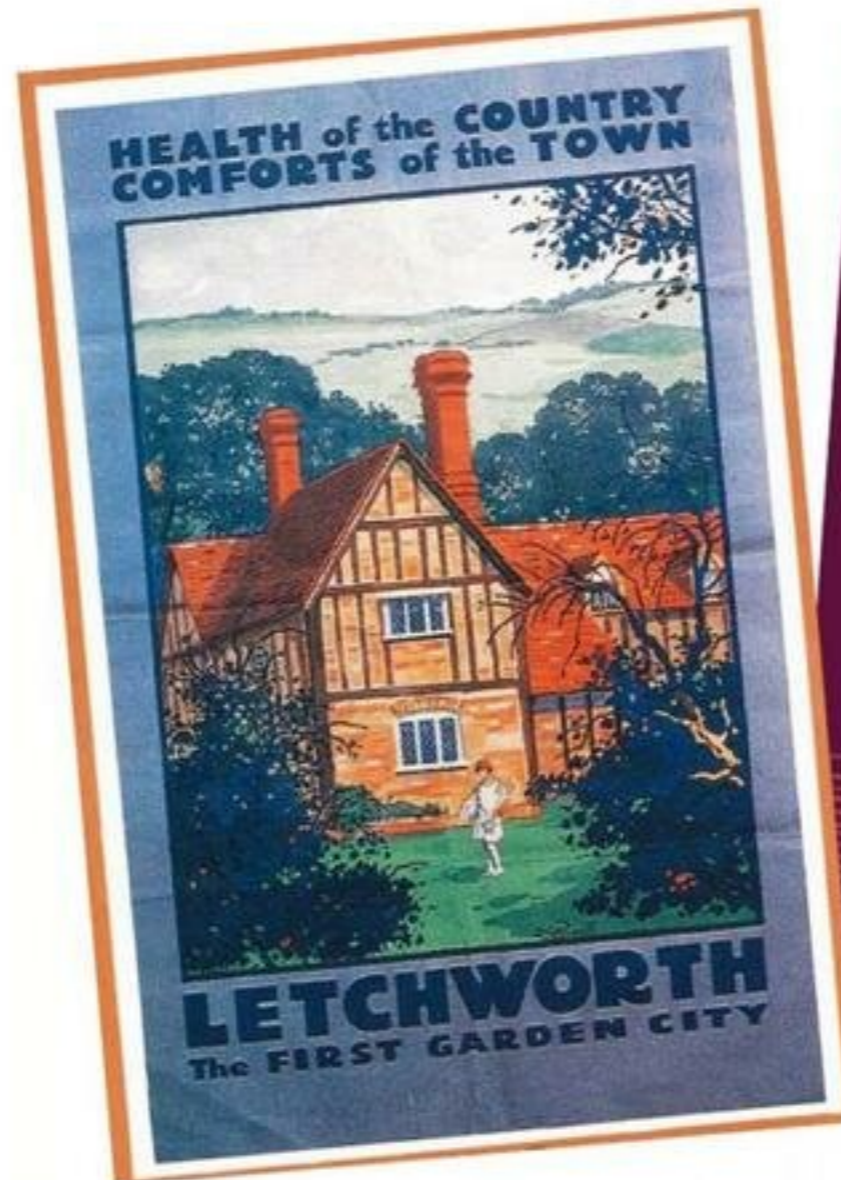
Mutual: owned by our customers

- £248bn assets
- 16.3m members
- 674 branches
- 18,500 employees

#2 largest UK mortgage provider

Domestic SIB (O-SII)

UK's most trusted financial brand

Building society, nationwide

HEALTH of the COUNTRY
COMFORTS of the TOWN

LETCHWORTH
The FIRST GARDEN CITY

Oakfield

Homes people want
and the planet needs

Content Summary / Agenda

1. Start of the Analytic Journey of Nationwide

2. Methodology Considerations – Direction of Travel
   - Prime mortgages of Nationwide Building Society portfolio at September 2019

3. Methodology Refinements and the Results
   - Results of regressing EE and Default controlling for borrower, mortgage and property characteristics
   - Replacing EPC rating with EPC on continuous form
   - IRB Rating System extension - Additive methodology testing

4. Benchmarking Against an Arrears Model

5. Conclusion
   - IRB Default Definition and Arrears results

- The EEFIG was established in 2013 by DG Energy and UNEP FI as is platform for public and private financial institutions, industry representatives, sector experts and policy makers to identify barriers to the long-term financing for energy efficiency and propose solutions.

- The landmark EEFIG 2015 report "Energy Efficiency – the first fuel for the EU Economy" highlighted that EE Investment is strategically important:
    - Public-private collaboration is required
    - Lack of evidence on the performance of EE investments makes the benefits and the financial risk harder to assess
    - Lack of commonly agreed procedures and standards for EE investment underwriting increase transaction costs

- EC and UNEP FI are guided by the EEFIG Steering Committee which meets quarterly with board members drawn from key constituencies.

EEFIG
ENERGY EFFICIENCY

FINANCE
UNEPINITIATIVE

The 200+ EEFIG members

- Public and private financial institutions (banks, investors, insurers etc.)
- Banking associations and investor groups
- Industry representatives and associations
- Energy efficiency industry experts
- Energy efficiency services representatives
- SME associations and expert representatives
- Civil society experts representing diverse energy efficiency stakeholder groups
- International Energy Agency (IEA)
- European Commission
- UNEP FI

EEFIG Representatives:
Rapporteur to the EC – Peter Sweatman

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EEFIG Representatives:
Rapporteur to the EC – Peter Sweatman
Secretariat – Carsten Glenting

- EEFIG runs multiple working groups including one on the assessment of the correlation of credit risk with the energy efficiency of the financed asset.

- Work in this group had been inspired by the contributions e.g. of Benjamin Guin, BoE.

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EEFIG
ENERGY EFFICIENCY

EEFIG Phases

1. **The EEFIG Report 2015**

2. **TOOLS:** DEEP and Underwriting Guidance 2016-17 | **ENGAGEMENT:** EEFIG local in Member States

3. **Smart Finance 2018-2022**

EEFIG Working Groups

- EE in the EU Taxonomy and Tagging of EE loans

- Evolution of EE financing practices

- Credit risk loan correlation with asset-level energy efficiency

- Multiple benefits of EE projects

- Further improvements of EE in industry

- EE financing in the framework of the next MFF

Nationwide
Building Society

Recap of Previous Activities – "Are green loans less risky?"

SR8 working group: "Are green loans less risky?"

CLIMATE & STRATEGY PARTNERS

Viegand Maagøe

d-fine
analytical. quantitative. tech.

COWI

Coordinated by

FINANCE UNEP INITIATIVE

EEFIG
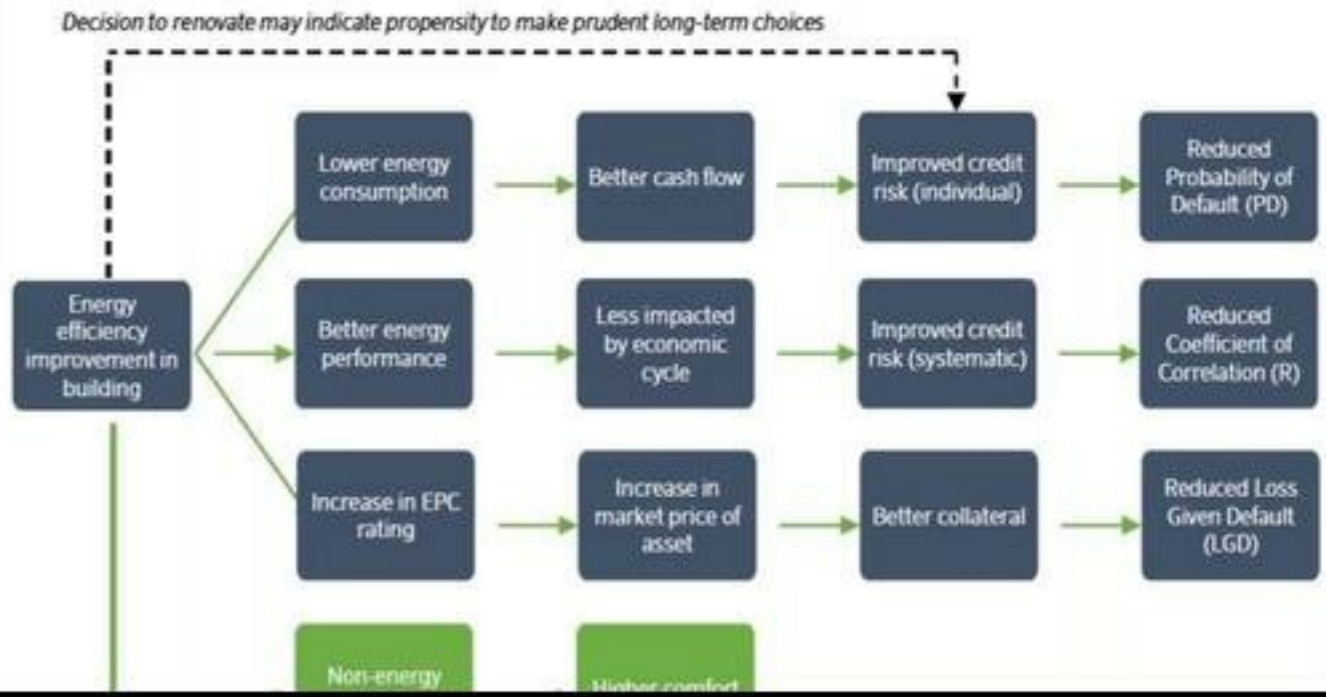ENERGY EFFICIENCY
FINANCIAL INSTITUTIONS GROUP

68 participants from major financial institutions assess the connection between energy efficiency and credit risk in terms of three major questions:
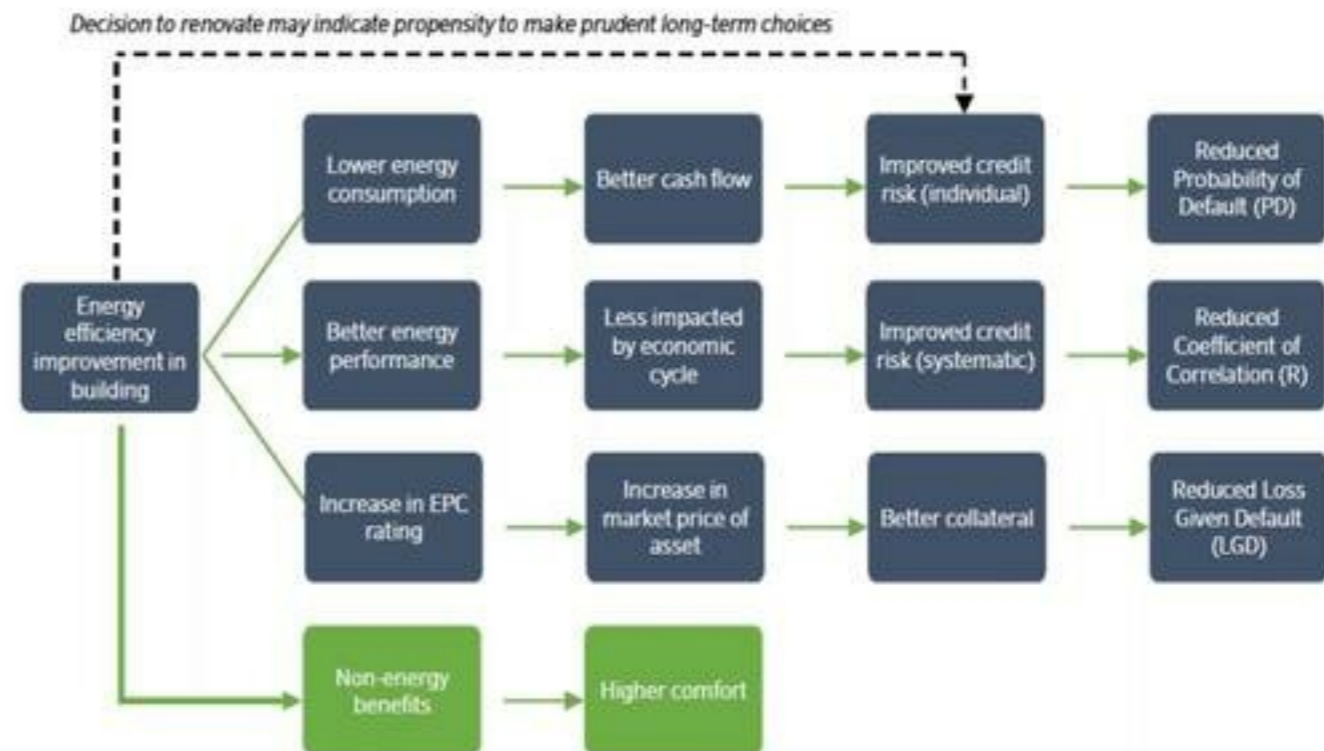
Building	Owner	Financial institution

		Are „Green Customers" with „Green Assets" less risky?
	1. Cedit Risk	
	2. Value	Are „Green Assets" more valuable and more liquid on default?
	3. Behaviour	Do green customers exhibit other

Decision to renovate may indicate propensity to make prudent long-term choices

Energy efficiency improvement in building →

- Lower energy consumption → Better cash flow → Improved credit risk (individual) → Reduced Probability of Default (PD)
- Better energy performance → Less impacted by economic cycle → Improved credit risk (systematic) → Reduced Coefficient of Correlation (R)
- Increase in EPC rating → Increase in market price of asset → Better collateral → Reduced Loss Given Default (LGD)

Non-energy ... Higher comfort

Matching rate by region

- UK EPC data from Ministry of Housing, Communities & Local Government (19m properties in England and Wales) were downloaded and merged with Nationwide's mortgage portfolio properties

- Various **algorithms** were developed to increase the matching of the databases, resulted in around **64% match** rate with even higher matching rate for new builds

- The modelling team tried **to replicate recent publications** (primarily the Bank of England EPC research on PD), but the result with a more strict "financial difficulty" definition as a target was non-intuitive, unstable and lead to methodology discussions with the EFFIG HUB on the possible improvements
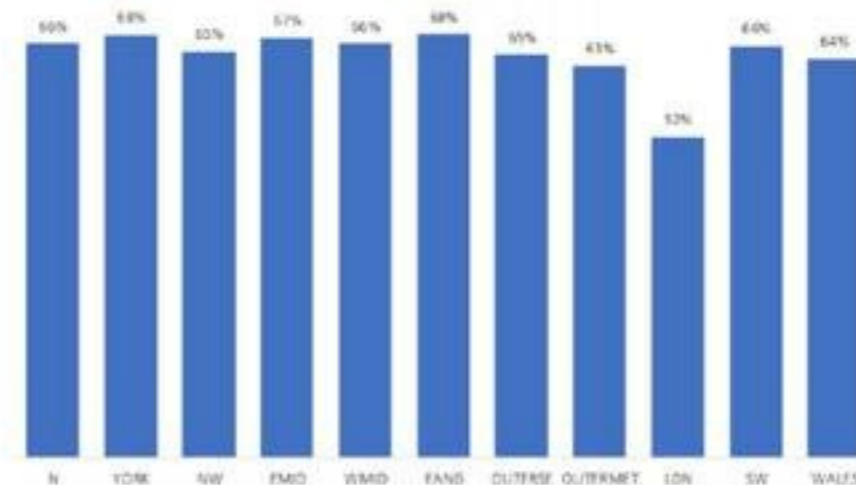
	Default (1)	Default (2)	Default (3)
Energy efficiency			
High energy efficiency	-0.00437	0.06633	0.05073
	(0.9383)	(0.2434)	(0.4084)
Medium energy efficiency	-0.08035	-0.06382	-0.07737
	(0.1522)	(0.2559)	(0.1688)

Several methodological ideas were discussed on the EEFIG HUB and method group

Methodological Considerations – Direction of Travel

- **Decide to use Prime residential mortgages** of Nationwide Building Society at September 2019 with either **IRB Default Definition (IRB DoD)**: DPD90 and Unlikeliness to Pay or **Arrears only** definition. ✔

- **Analyse** non-standard mortgages including government schemes and their impact on the results (such as Help to Buy, Shared Ownership or Right to Buy). ✔

  - Treatment of mortgage origination year (changes in EPC methodology and accuracy) ✔✗

  - Additional Information: cost of different property type, property size, inspection date, impact of recession period, value of the property, profiling (mosaic) etc. ✔✗

  - Usage of IRB rating system (extend the core model ✔ or build an add-on ✔)

  - Usage of EPC in a continuous form ✔

- **Compare models with different target variable** : IRB DoD / Arrears only ✔

- **Test alternative methods**: Cox Proportional Hazard model (survival method) ✗

The research is still ongoing, but several improvements were implemented based on the agreed

- **Decide to use Prime residential mortgages** of Nationwide Building Society at September 2019 with either **IRB** Default Definition (**IRB DoD**): DPD90 and Unlikeliness to Pay or **Arrears only** definition. ✓

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**The research is still ongoing, but several improvements were implemented based on the agreed direction based on the methodology group discussions**

Risk Profile – The cause of the anomalies: government schemes
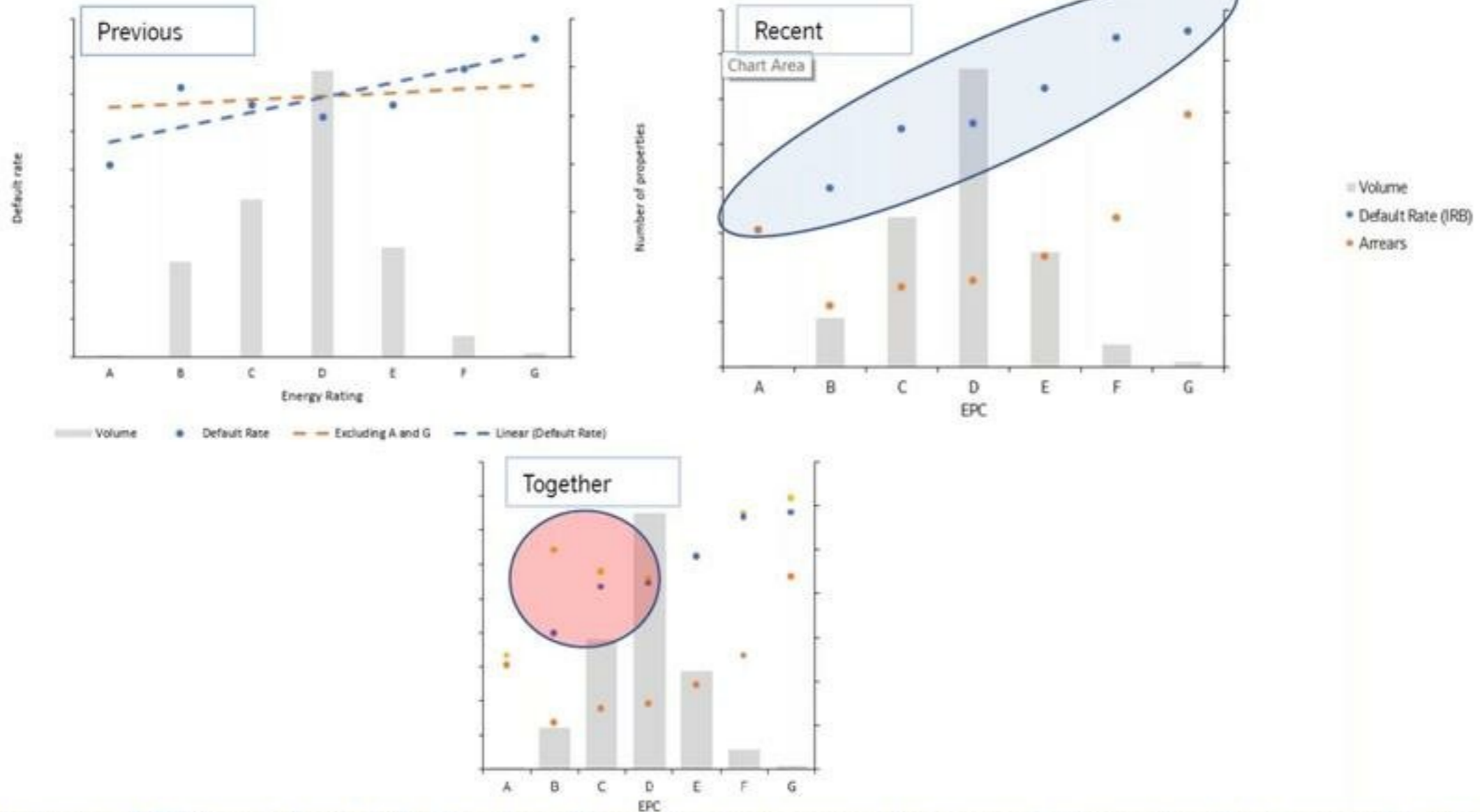
Analysing EPC impact on default rate without the government schemes eliminates the anomaly in the default rate relationship and create a clear negative relationship between energy efficiency and defaults
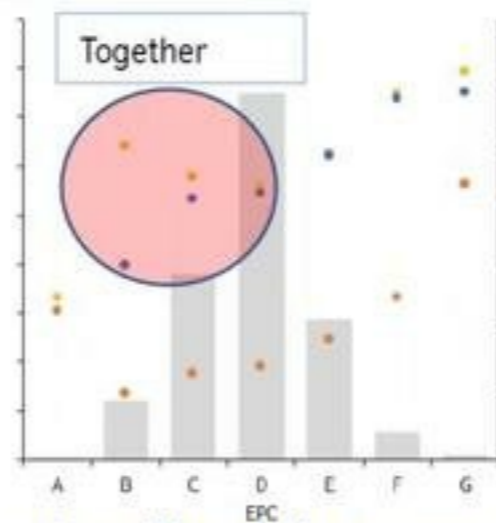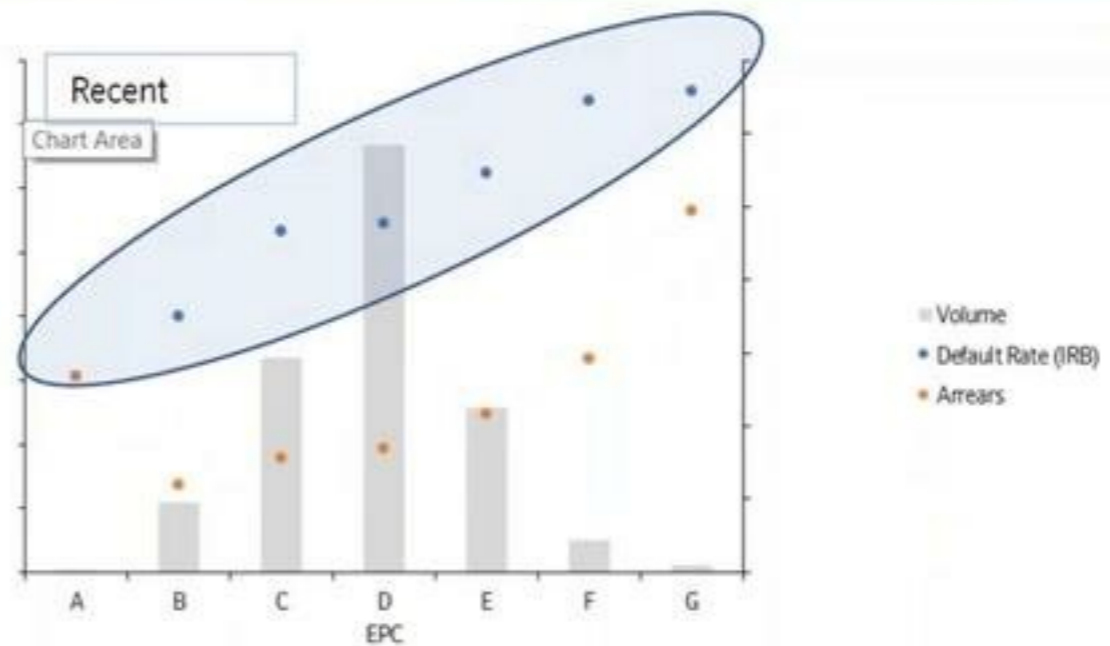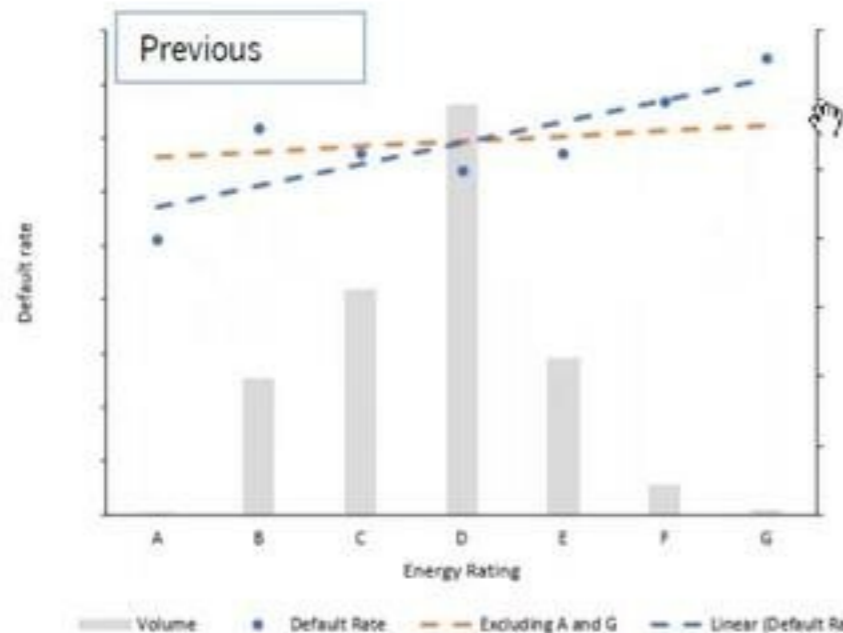
Analysing EPC impact on default rate without the government schemes eliminates the anomaly in the default rate relationship and create a clear negative relationship between energy efficiency and defaults

Modifying the initial research – Stable / Intuitive relationship between EE and default risk

	Default (1)	Default (2)	Default (4)	Default (5)	Default (6)	Default (7)	Default (8)	Default (9)
Energy efficiency								
EE Continuous								
High energy efficiency	-0.2699***	-0.2772***	-0.2641***	-0.2688***	-0.2265***	-0.238***	-0.2148***	-0.1979***
	[0.06452]	[0.06453]	[0.06459]	[0.06459]	[0.06474]	[0.06482]	[0.06489]	[0.06497]
Medium energy efficiency	-0.1848***	-0.1868***	-0.18***	-0.1871***	-0.1735***	-0.171***	-0.1463**	-0.1691***
	[0.05857]	[0.05858]	[0.0586]	[0.05861]	[0.05863]	[0.05864]	[0.05867]	[0.05871]
Main control variables								
Household Income (£'000)	Borrower	-0.00877***	-0.00881***	-0.00977***	-0.00749***	-0.00662***	-0.00379***	-0.00497***
		[0.000888]	[0.000883]	[0.000898]	[0.000963]	[0.00098]	[0.000925]	[0.000934]
Loan Term (Years)	Mortgage Control			-0.01524***	-0.03767***	-0.029***	-0.02774***	-0.0043	-0.01962***
				[0.003214]	[0.003947]	[0.004032]	[0.004033]	[0.004309]	[0.004457]
Original LTV (%)					0.01415***	0.01017***	0.009742***	0.01199***	0.01244***
					[0.001438]	[0.001488]	[0.001487]	[0.00147]	[0.001439]
Valuation Amount (£/sqm)	Property Control					-0.00022***	-0.00025***	-0.00026***	-0.00016***
						[0.000024]	[0.000025]	[0.000024]	[0.000024]
House Indicator							-0.2772***	-0.1477**	-0.1097
							[0.06585]	[0.0671]	[0.06721]
Age								0.03663***	0.01869***
								[0.002653]	[0.002988]
Age*Recession									0.0178***
									[0.001228]
Regional x Recession Ind	No	No	No	No	No	No	No	No
Inspection Year FE	No	No	No	No	No	No	No	No
Observations	657,838	657,838	657,838	657,838	657,838	657,838	657,838	657,838
Gini	5.2%	16.09%	16.64%	20.7%	24.8%	25.5%	31.1%	34.0%

Results

- **High/Medium vs. Low:** High and medium energy efficient properties seem to be less likely to default than low energy efficient properties.

- Intuitive relationship is kept even after introducing the **control variables** (improvement from previous results)

- Controlling for **borrower** characteristics such as **household income** does not jeopardize this relationship

The tested methodological / sampling enhancements suggest a clear and intuitive relationship existence with default probability.

	Default (Continuous)	Arrears (1)
Energy efficiency		
EE Continuous	-0.00686*** [0.001831]	
High energy efficiency		-0.4671*** [0.107]
Medium energy efficiency		-0.3508*** [0.09429]
Main control variables		
Household Income (£'000)	-0.00494*** [0.000934]	-0.00916*** [0.001699]
Loan Term (Years)	-0.0195*** [0.004457]	0.01116 [0.007219]
Original LTV (%)	0.01245*** [0.001438]	0.009614*** [0.002439]
Valuation Amount (£/sqm)	-0.00016*** [0.000024]	-0.00017*** [0.00004]
House Indicator	-0.1151* [0.06705]	-0.3041*** [0.1068]
Age	0.01874*** [0.002988]	0.007005 [0.004861]
Age*Recession	0.01773*** [0.001227]	0.01664*** [0.002142]
Regional x Recession Ind	No	No
Inspection Year FE	No	No
Observations	657,838	657,838
Gini	33.8%	34.0%

- The regression result shows highly significant Energy Efficiency coefficient when using the **continuous** version of the EPC indicator.

- Benchmarking our models with only targeting **arrears** instead of overall financial difficulty shows similar results in the EPC relationship with "bad rate*" with some change in parameter signs, which is to be investigated, but limited only to the control variables. (*Bad rate in this context is either IRB default definition or only arrears)

Replacing EPC ratings with the continuous form of EPC "scores" in the model, further improve the overall confidence in the relationship

	Default (1)	Default (2)	Default (3)	Arrears (1)	Arrears (2)	Arrears (3)	Arrears (4)
Energy efficiency							
EE Continuous	-0.00898*** [0.001777]		-0.00376* [0.001946]	-0.01572*** [0.002843]		-0.01065*** [0.003129]	
High energy efficiency							-0.3058*** [0.1139]
Medium energy efficiency							-0.2495** [0.101]
Main control variables							
IRB Credit Score		-1.0551*** [0.01164]	-1.0536*** [0.01166]		-1.109*** [0.01673]	-1.1064*** [0.01675]	-1.1069*** [0.01675]
Original LTV							
Loan Term (Years)							
House Indicator							
Valuation Amount (£/sqm)							
Regional x Recession Ind	No	No	No	No	No	No	No
Inspection Year FE	No	No	No	No	No	No	No
Observations	657,838	657,838	657,838	657,838	657,838	657,838	657,838
Gini	4.7%	70.28%	70.31%	7.9%	81.1%	82.0%	81.3%

Control variables are already covered in the "IRB Credit Score"

IRB Credit Score: IRB behavioural scorecard.

High discriminatory power (Gini = 70%) using additional information about past payment customer behaviour, the collateral and the individual itself.

EPC rating still significant after the inclusion into the IRB behavioural scorecard which allow for a potential capital allocation tailored to Energy Efficiency (next slide).

Utilising the full benefit of the IRB rating system showed that the control variables on top of the IRB model output are not necessary, but the EPC rating has added value to the IRB ratings

Capital change by Energy Efficiency
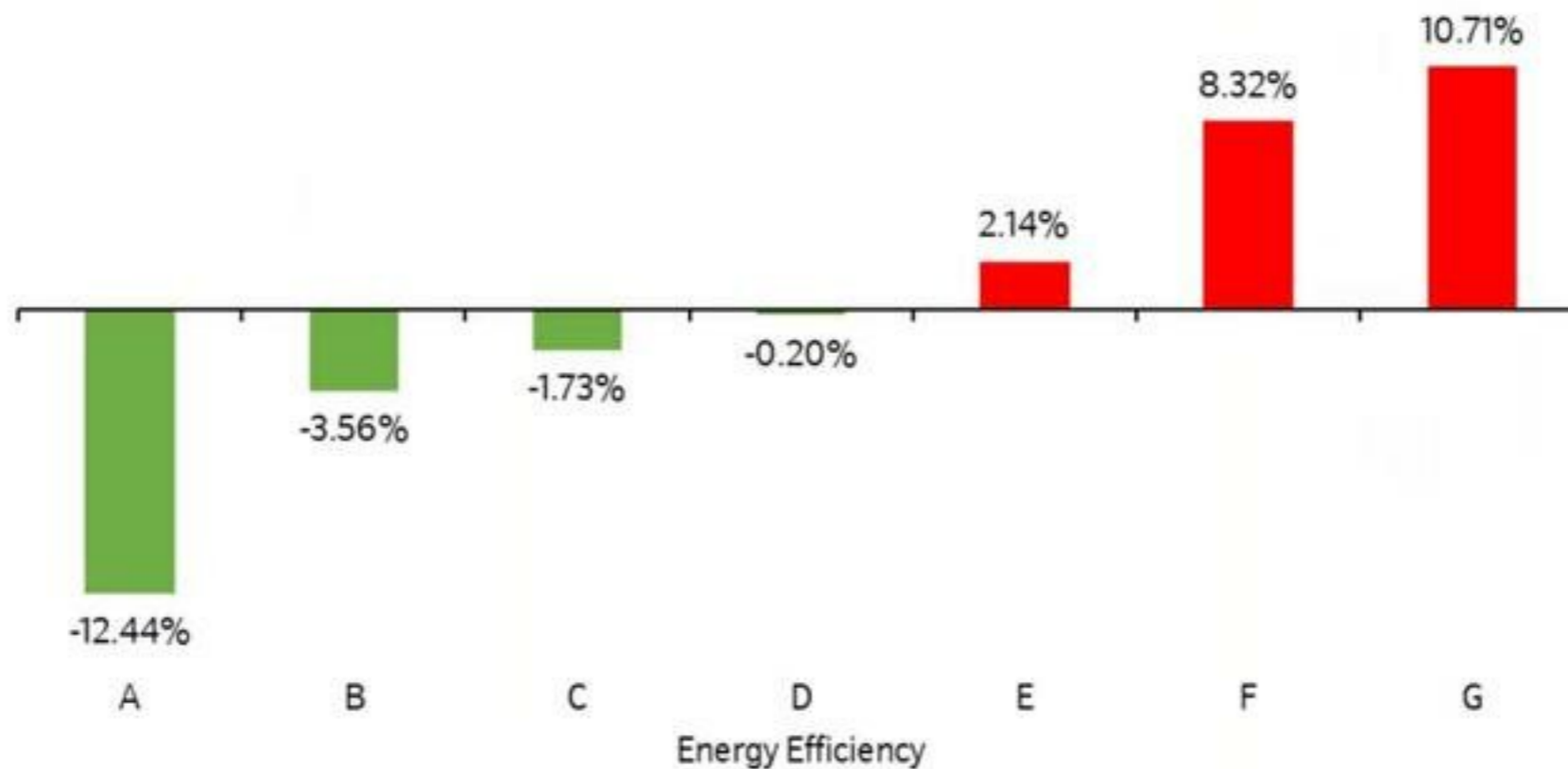
Whilst the overall capital requirement did not change for the sample, the inclusion of EPC into the IRB rating system allows for better capital allocation by EPC ratings with clear incentive towards better ratings

EPC overlay on the IRB rating system of Nationwide with CRR / EBA compliant default definition

- Data suggest that there is a **significant difference** in the likeliness to default between high/medium (A/B/C/D) energy efficient properties and low energy efficient properties after controlling for characteristics of the customer, the mortgage or the property that might affect this relationship or **building it into the IRB rating system**.

- Analysing only "core" mortgages without **special government schemes** offered on the market clarified the previous results related anomalies.

- Statistically significant negative relationship is also confirmed by introducing the **continuous form of energy efficiency** "rating".

Model benchmark against "serious" financial difficulty (Month in Arrears ≥ 3)

- The model and the relationship is reassured using reduced form of **financial difficulty (serious missed payments)** which also suggest that there is also a significant difference between High (A/B/C), Medium (D) and Low energy efficient properties.

Model refinements and next steps:

- There are still quite a lot of **refinement possibilities** in the current methodology used, and also alternative methods might be evaluated, which is planned to be progressed continuously.

Model Validation

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29 March 2021

- **Alternative clustering** driven by internal reports have also been analysed with similar results: High Energy Efficient (A, B), Medium Energy Efficient (C, D), Low Energy Efficient (E, F, G).

- Not extreme **correlation** between the control variables, levels of the VIF (Variance Inflation Factor) values indicate no violation of the model **multicollinearity** assumptions.

- Treatment of **outliers** have been done following the scorecard development methodology to not reduce the number of default cases in the sample.

- Additional analysis have been conducted to see for **heterogeneities** in the EPC-Default relationship for different levels of household income which might improve the results.