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Valuing energy performance in home purchasing: an analysis of mortgage lending for sustainable buildings

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Abstract

Many UK lenders consider energy costs, but only as it relates to information about the customers and not the energy performance of the building. Lenders could include more detailed energy costs estimates that reflect energy performance alongside other major household expenses when assessing customer affordability. At present, energy performance ratings required for all homes sold in the UK are of dubious quality and generally do not accurately reflect the likely energy costs. However, if lenders were to include energy performance in their mortgage calculations this might have the effect of improving the accuracy of energy performance ratings through market pressure. It may also have the consequence of increasing the value of more efficient homes, which would have lower energy costs and improve its affordability for customers. It may also offer an opportunity for lenders to extend mortgages to improve the dwellings energy performance due to the potential increase in value. In this work, we set out the implications of mortgage lenders using the dwelling's energy performance as part of their energy cost calculations. We also illustrate how improving the accuracy of ratings can achieve more precise estimates of energy costs. The implication of including energy performance ratings when providing mortgages could result in £billions for lenders in terms of loan extensions and more accurately property values. It could also help potential purchasers understand the real costs of the properties they purchase.
Keywords: mortgages; lending; fuel bills; energy performance certificates; UK

1. Introduction

Currently, median housing-related energy costs accounts for 7% of a household's weekly expenditure in Great Britain, which means that over 50% of households spend more [1,2]. These costs are related to the energy efficiency of the property and energy-related services (i.e. hot water, cooking, lighting and appliances) sought by the occupants.

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Yet, UK households remain resistant to undertaking energy efficiency improvements to their home that would help reduce the cost of fuel expenditure [3]. Wilson et al. suggests that this is due in part to the limited understanding of the potential benefits the retrofits might bring, such as warmer homes and lower bills, but also the risk or challenges associated with the retrofit. Ultimately, this has meant that energy performance remains a lower priority when seeking to purchase a dwelling compared to other motivating purchasing factors (i.e. neighbourhood, commute, local schools, access to services). The Energy Performance Certificate (EPC), a measure of the relatively energy efficiency of a dwelling, which is required for all rentals or sales of dwellings in the UK, is seen mostly as a regulated requirement with little real worth [4]. Given the relatively high cost of energy, and the need for mortgage lenders to consider both earning potential and major expenditures, what impact would there be on mortgage lending if lenders were to make use of energy performance ratings? What might happen if the energy performance of a dwelling was reflected in their value? If such an outcome could be achieved, there may be an opportunity that property owners would see energy efficiency along a similar nature to valuing kitchens and bathrooms, whereby investing in energy performance could result in a higher sales price for their home.

There is emerging evidence that the energy performance of dwellings is resulting in tangible increases in dwelling value at the point of sales. Research in the UK found that higher energy performance ratings were associated with higher purchase prices; approximately 5% and 1.8% for the higher bands (compared to the middle band) [5]. However, the research highlighted that there were risks of over attributing this relationship as it was possible the analysis was also finding associations with latent factors. Yet there may be other benefits, in particular to lenders, of being involved in selling more energy efficiency dwellings. Kaza et al. found that dwellings in the US with higher energy performance levels had lower risk of default [6].

As UK Government climate change policies begin to take hold and the requirements for improving energy performance of the building stock become more pressing, such as in the private rental sector when the Minimum Energy Efficiency Standards (MEES) come to bare in 2018, there may be even more potential for a shift in both institutional and public attitudes towards valuing energy performance. However, future regulatory requirements could be supported by involving a key part of the property market, i.e. the finance sector, in the near term.

An opportunity to increase the importance of energy performance in the lending and purchasing process in the UK has arisen as the result of the Mortgage Market Review (MMR). Under the MMR, lenders are required to assess how much loan a customer can afford and therefore to determine what their potential incomes and outgoings are. Therefore, mortgage lenders must now consider to a greater extent the prospective borrowers' outgoings when calculating the affordability of the expected repayments. The median UK energy costs are approximately £1,300 (£729 for gas and £577 for electricity) [7], and the ONS estimate the median after tax income is £18,000 (£20,300 before tax)[2]. This means that half of all households spend at least 7.2% of their after tax income on housing heating and electricity. Although the past year has seen a drop in energy prices globally, the trend over recent years has been a rapid increase in fuel costs as compared to income (see Figure 1). Therefore, responsible lenders should better account for this growing area of household expenditure when determining how much to lend.

In order for mortgage lenders to assess the merits of including energy performance as a part of the lending calculation, it is necessary to first determine how much improvement there might be of including such information compares to existing methods for calculating fuel expenditure.

As a ready source of information on the energy performance of dwellings that are sold or rented in the UK, the use of the EPC in mortgage calculations would be a reasonable resource for lenders to draw on. This paper therefore looks at how lenders currently account energy costs; whether and how the accuracy these calculations could be improved; and the impact this could therefore have on lenders' risk profiles. First, we provide a brief background to EPCs and their limitations. We then go on to outline how EPCs might be used to estimate actual energy demand and how these might be used in a mortgage calculation. We also discuss the role of EPCs, and the long-term implications that their inclusion in mortgage affordability calculations could have for their accuracy and quality.

2. Background

The European Energy Performance of Buildings Directive (EPBD) specifies the requirements for issuing and rating the energy performance of buildings in the EU [8]. For housing, a certificate is required when a dwelling is constructed, rented or sold and must provide a rating of its energy performance and CO_2 emissions and must provide a set of recommendations for energy performance improvement. The Directive requires that the methodologies used to calculate the ratings are based on a general framework set out in the EPBD, which take into account: thermal characteristics, heat and hot water systems, location and orientation, ventilation, air conditioning and in- door climate. The method (as defined under EN 15217) must: 1) calculate the overall energy performance index in total and per area unit of energy and CO_2, 2) provide an overall minimum efficiency level, 3) provide a breakdown of energy use by dwelling component, and 4) display the results on an A to G banding. These models are a mixture of simplified calculations, plus assumptions based on empirical evidence or informed expert opinion and 'rules of thumb'.

In England, Wales and Northern Ireland, the government, has mandated EPCs since 1st October 2008, with an EPC being required when a home is rented or sold (including new homes) and the rating is valid for 10 years. The EPC methodology is based on the government's Standard Assessment Procedure (SAP) for new dwellings with a reduced level of data input when calculating EPC's for existing dwellings (RdSAP). The A to G scale coincides with SAP ratings, where a 'D' rating is the median value for all dwellings, based on national estimates [9]. The ratings are calculated using a standard set of assumptions regarding the energy performance using characteristics of the home, such as age, layout, construction, the heat system type, lighting and the levels of insulation. The certificates are standardised against a 'notional' building to provide a benchmark that allows for comparison between properties. The calculations for energy and cost of running the homes assume a 'standard occupant' that has defined heating pattern and temperature and an average fuel price and climate. All EPC's are based on estimated energy use.

The average SAP rating for English houses is 51.4, which is an 'E' rating [9]. As of November 2012, there were approximately 4.2 million valid EPCs [10]. EPC models are often used to calculate the cost effectiveness of energy efficient improvements and the change in demand following a retrofit. However, the EPC calculated saving will only be accurate for dwellings with 'normative' behaviour. There are clear limitations to the use of EPC as a proxy for 'actual' energy demand, especially for space heating [11–15].

In meeting the MMR requirements to assess what repayments a customer can afford many UK lenders already consider energy costs, but only as part of a broad estimate of household expenditure with no reference to the energy performance of the building. In this work we explore the extent to which mortgage lenders could estimate energy costs using data that is already readily available to them, including properties' EPC rating.

3. Methods

In order to examine the implications of mortgage lenders using the dwelling's energy performance as part of their energy cost calculations, we accessed detailed data on English dwellings. Using a simple statistical modelling approach, several energy bill models were developed to test the implications of using a dwelling's energy performance information to estimate its actual energy expenditure, which included the extent to which EPCs could be used in mortgage lenders' bill estimation process. A dataset that included detailed information on the energy performance and other physical characteristics of English dwellings along with information on the household was used. In the modelling, focus was placed on using data points that would be readily available from the prospective buyer (i.e. from the property's EPC or other home buyer reports) and/or from a mortgage lender's normal application and assessment process. The following section further describes the data used in this analysis and the approach to the modelling.

3.1. Data set

The data analysed for this paper formed part of the Energy Follow-Up Survey (EFUS), commissioned by DECC. The EFUS is a sub-sample of the English Housing Survey (EHS), which is a representative survey of English dwellings and households therein. The EFUS data used here comprised three parts, including: a) all self-completed survey asking about details of their dwelling and their heating practices; b) gas and electricity meter readings in a sub-sample of homes used to estimate a yearly consumption; and c) details that could be drawn from the EHS. The sample size for EFUS was N=2616; meter readings were available for N=1345 households. Of those 1345 households, another 345 were excluded to avoid bias in the analysis based on four criteria: (1) positive reply to the question if physical changes to the dwelling had been carried out since the last EHS, (2) positive reply to the question if the household composition had been changed since the last EHS, (3) annual energy consumption considered an outlier (± 3 SD from the mean), and (4) usage of a heating fuel that was not gas or electricity. The last criterion was included to avoid too small sub-samples, e.g. only 12 households had a solid-fuel system and only nine a communal or other system.

3.1.1. Variables used in subsequent analysis

As highlighted above, for the purposes of the modelling the predictors used comprised building features, i.e. factors that are pertinent to the building and would be collected as part of the EPC input, and household characteristics that would normally be collected by a mortgage provider. The variables were chosen based on previous research [16], and limited by what was available in the EFUS data.

Table 1 summarises the selected building and household variables used the analysis. Again, though other characteristics of the dwelling and household may play an important role in determining the amount of fuel used (i.e. occupancy patterns, temperature settings, heating controls, appliance ownership/use), only those variables likely to be available to lenders were considered. This avoided the complications that would be associated with self-reported variables which could, for example, change in a new property compared to the mortgage applicant's previous dwelling (and which could be deliberately mis-represented).

Table 1 – Overview of building variables and their frequencies

Variable (abbreviation)	Categories (N)
Floor area (FloorArea)	n/a (continuous: M = 91.12 m2, SD = 43.07)
Dwelling type (DwType)	Converted & purpose built flat (151), detached (234), end terrace (119), mid- terrace (119), semi-detached (305)
Government Office Region (GOR)	East (108), East Midlands (68), London (106), North East (73), North-West (176), South East (134), South-West (96), West Midlands (97), Yorkshire and the Humber (133)
Dwelling age (DwAge)	pre 1919 (142), 1919-44 (171), 1945-64 (229), 1965-80 (233), 1981-90 (77), post 1990 (139),
Wall type (WallType)	9-inch solid wall (139), cavity uninsulated (302), cavity with insulation (489), other (63)
Double glazing (DblgGlaz)	entire house (786), more than half (117), less than half (38), no double glazing (35)
Loft insulation (LoftIns)	150mm or more (457), 100 up to 150mm (257), none – up to 100 mm (172), not applicable - no roof directly above (105)
Fuel type (Fuel)	electrical system (46), gas system (945)
SAP rating (SAP)	C (134), D (552), E(256), F&G (49)
Household size (HHSize)	n/a (continuous: M = 2.37, SD = 1.24)
AHC (After-Housing-Costs) equivalised income quintiles (Income)	1st quintile – lowest (145), 2nd quintile (218), 3rd quintile (209), 4th quintile (209), 5th quintile- highest (210)

3.1.2. Dependent variable: Annualised combined energy cost

The analysis used the annualised energy consumption in kWh converted into a total annual cost (in £). This value either reflected the sum of both gas and electricity data, or just electricity consumption for households that were not connected to the gas grid. To avoid potential variation in the price paid for fuel at an individual household level, 2011 values for gas and electricity (as p/kWh) for each region were used. The values are drawn from DECC regional energy price statistics for the residential sector [17].

3.2. Statistical analysis

Linear regression analyses were used to test the predictive power of different variables in explaining annual energy costs. A baseline model (model 1) was built to reflect the type of information mortgage lenders typically use to model energy bills (region, income, household size). Additional models were then built to illustrate a) the effect of adding EPC ratings to the base model, and b) additional information known to have an impact on energy use. The models explanatory power was compared to determine a preferred model. The preferred model (model 5) encompassed all relevant predictors that could be attained by the mortgage lenders from an EPC and a mortgage application.

A potentially problematic issue in analysis of these kinds of data is that different predictors are correlated, e.g. dwelling type is related to floor area as in that detached houses tend to be larger and floor area is related to household size, i.e. more people live in bigger dwellings. Whilst this collinearity does not bias the overall explanatory power of a model, it can create unstable and unreliable coefficients for the predictors. This paper focuses more on overall explanatory power of models, but checks for collinearity when inspecting model outputs and selecting for parsimony.

4. Results

The modelling results for the 'mortgage lenders' model (see model 1 in Table 2) illustrates that using only a limited amount of information to predict dwelling energy costs (gas and electricity) produces a model with low explanatory power (i.e. ~18%, derived from R-square value) (see Figure 1). As more information is added to the model, the greater the explanatory power of those selected predictors, which is expected. Equation 1 gives the equation of energy costs (e_costs) is a function of dwelling characteristics (Dwell_char), which are added for each model (1-n), and error. A model that used dwelling and energy performance variables that are readily available to mortgage lenders from the EPC and the mortgage consultation with prospective purchases (model 5), increases the predictive power to approximately 38% of fuel costs. While not a great overall improvement, this is a twofold in the power of the current 'mortgage lenders' model, achieved using information that would be readily available to a mortgage assessor.

While Figure 1 shows model results for the stock, i.e. 'average' dwelling, a more visible difference between the models is the improvement in predicting the variation of fuel costs against the true distribution of costs. Using an example of the variation in fuel costs for dwellings built pre-1900, Figure 2 shows the distribution of modelled and actual energy expenditure from model 1 and model 5. The improvement in the capture of the spread is clear, with model 5 being better at predicting the extremes of the distribution, despite predicting relatively similar averages for the group. It therefore reasonable to conclude that it does a much better job of reflecting the real variation in fuel costs.

Figure 3 illustrates the difference in how these models might be used and presented to a mortgage lender to represent an individual dwelling. The figure shows an example of the difference between the two models for estimating the energy costs of a 3-bedroom, semi-detached, dwelling in the North West region with differing age and EPC bands (i.e. a typical 'New Build' and 'Existing' dwelling) using Model 1 and Model 5. The difference in the predicted and actual fuel costs for Model 1 are considerable, particularly with the 'New Build' dwelling prediction which is 2.4 times greater.

$$E_{cost} = f(Dwell\_char_{1-n}) + e \qquad (1)$$

Table 2 - Energy cost model parameters using EFUS (see Figure 1 for class variables)

Models	DF	Sum of Squares	Mean Square	F Value	Pr > F	R-Square	Coeff Var	Root MSE	Mean Energy Cost
Model 1	9	5.66E+09	6.29E+08	1552.06	<.0001	0.003	57.8	636.5	1100.9
Model 2	14	1.15E+11	8.20E+09	21680.3	<.0001	0.069	55.9	615.1	1100.9
Model 3	19	2.84E+11	1.50E+10	44403	<.0001	0.171	52.7	580.4	1100.9
Model 4	22	4.11E+11	1.87E+10	61006.3	<.0001	0.247	50.2	553.1	1100.9
Model 5	19	3.92E+11	2.07E+10	67100.8	<.0001	0.247	50.2	554.8	1104.2

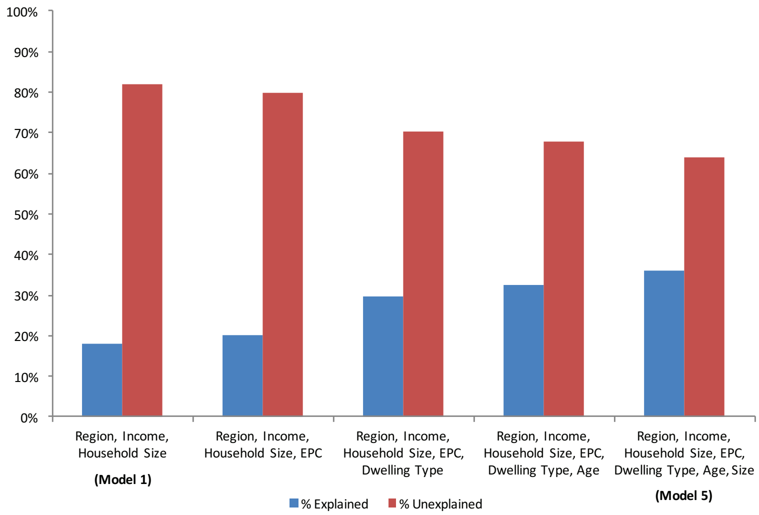

Figure 1 – Comparison of regression models of energy costs using EFUS data

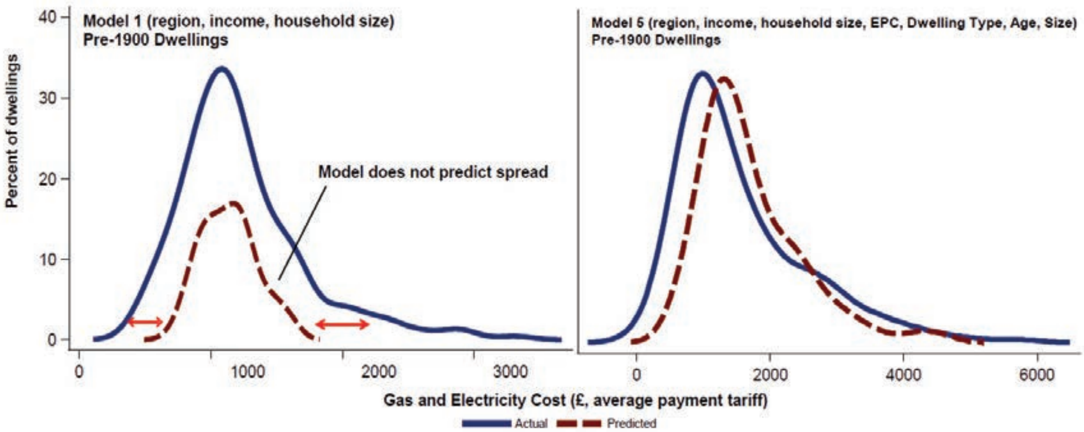

Figure 2 - Distribution in predicted and actual fuel costs using model 1 and model 5

When entered into a mortgage lenders calculator, the implications of the difference in estimated fuel costs between the models could have an important impact on risk associated with the amount lent. The differences between the two models can be compounded over the course of the 25-year mortgage, along with an assumption of energy price increases, the value of the error becomes quite significant from a mortgage lender's risk management perspective. Using the same examples described above of the 'New Build' and 'Existing' dwellings, the 'Existing' could have an annual estimated bills of £1200 (model 1) or £940 (model 5), compared to the mean actual bill of £960, see Figure 4. With an annual energy price increase of 5%, the total difference between model 1 and the projected actual bill over the typical duration of a mortgage (25 years) is £11,455 (compared to only £955 for model 5). This rises to £23,603 if the annual rate of energy price inflation were to increase to 10%.

The estimated annual bill for the ‘New Build’ using Model 1 is £1600 and Model 5 predicts £650, compared to the actual bill of £650. Under the same mortgage and energy price conditions outlined above, the cumulative difference between Model 1 and the projected actual bill is just over £45,000 using a 5% energy price rise. This rises to almost £95,000 if the annual energy price rise were 10%.

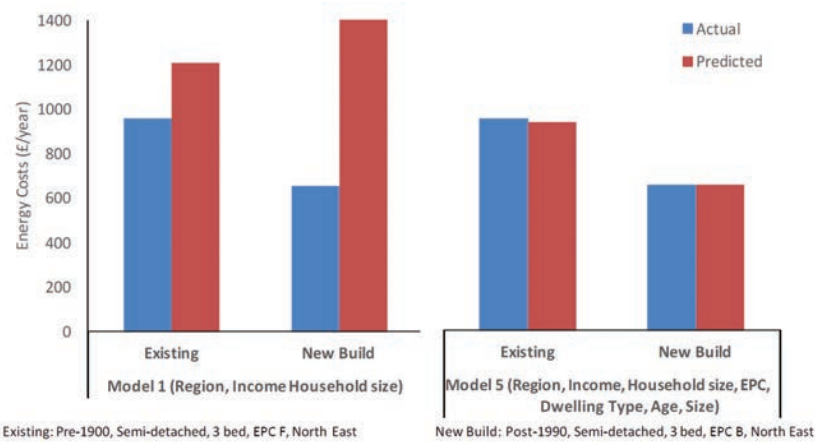

Figure 3 - Estimated fuel costs for a 3-bedroom, detached, pre-1900 dwelling in the North West region using two models.

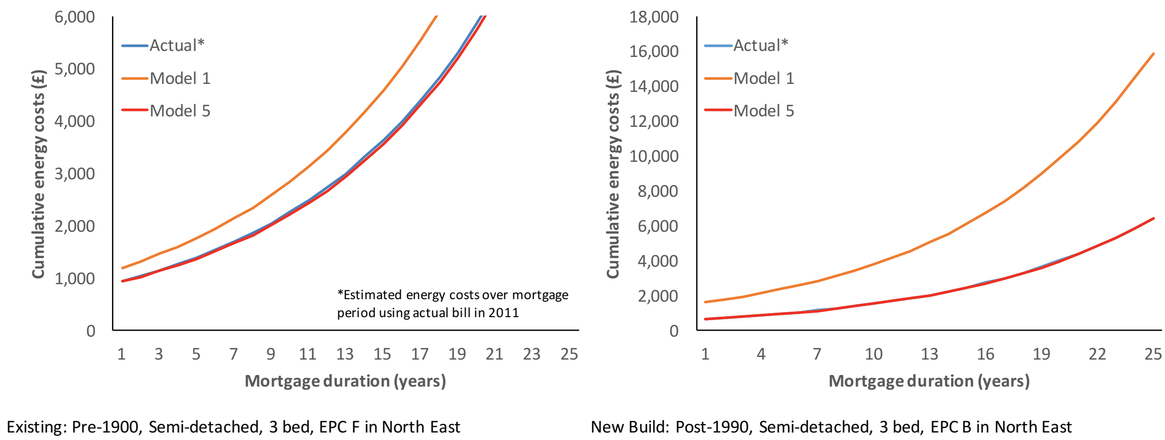

Figure 4 - Estimated cumulative fuel costs using two models

5. Conclusions

The analysis shows that significant improvements could be made to the way in which lenders account for energy costs in their mortgage calculations. Importantly, these improvements can be made by using a model that relies on data that is already available to the lenders or borrowers for the properties they are lending against (i.e. the current EPC rating). Even for a “typical” house, the research shows that by not accounting for energy costs, a lender could over- or under-lend by many thousands of pounds over the life of the mortgage.

At the more extreme ends of the scale, in properties that are highly inefficient or highly efficient, this could be substantially higher. And, when aggregated across large mortgage portfolios, it could quickly run into many millions or even billions of pounds. If lenders could be persuaded to start using a more detailed model to calculate energy costs, they would therefore have an opportunity to significantly reduce risk in their lending. In the light of recent concerns around irresponsible mortgage lending, the relative ease with which this could be achieved could prove an attractive proposition for those seeking to tighten up their practices.

While the research shows that EPC ratings have a role to play in these calculations, it is also known that they are not currently a robust indicator of likely energy costs. To some extent, this is a result of the shortcomings of the EPC methodology, which accounts for only a limited amount of information of the dwelling's energy performance. However, limitations from their usefulness also come from the low value that is currently attached to EPCs, which in turn leads assessors and households to pay limited attention to their accuracy. By including EPCs as part of a mortgage calculation model, however, this issue could be coincidentally addressed, i.e. they would assume significantly more importance and value in the transactions process, with a greater incentive for them to be done to a high standard.

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