Size and the City – The potential of downsizing in reducing energy demand and increasing quality of life

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Abstract

Recent decades have seen a tremendous growth in the population, particularly in cities. London, for example, has increased from about 6.8 million to 8.2 million over 20 years from 1991 to 2011. Additionally, we have seen substantial demographic change, with an increasing life expectancy and other factors resulting in a larger number of households with only one or two people. One consequence of this is that older people can end up living in inappropriate housing being too large for their needs, with high heating bills and stairs restricting mobility. In addition, this also contributes to the decreasing availability of housing for the growing population. Ultimately, this can lead to unnecessary use of energy and carbon emissions.

One potential approach would be to promote downsizing amongst those who live in larger-than-needed properties (defined in relationship to a standard). Some people might desire to live in large properties – for those the question might be how downsizing could be rendered an attractive option. For those keen on downsizing, the question is more how it can be realized, i.e. what barriers need to be removed and what help given. In any case, for those who downsize, this could result in significant release of equity (for home owners) or reduced rent, in addition to lower bills and potentially more suitable accommodation in terms of access and mobility. Potential benefits for the wider population would be greater availability of housing stock.

This paper will address this issue in different ways. Firstly, empirical data will be presented on the effect of housing size on energy consumption. A sample of N = 991 households, approximately representative for the English population, is analysed with regard to the impact of housing size and housing type on energy consumption. Results show that those two predictors are of greatest importance, and together explain about 29% of the variability in the log-transformed annual energy consumption, surpassing all other variables. In addition, the analysis calculates the amount of under- and overpopulation of housing to give an estimate of the distribution of living space. Secondly, the paper will discuss the benefits of downsizing for the population. A detailed literature review is performed. The results address the benefits of downsizing and highlight which factors would promote downsizing. One issue that has been shown previously, was that those who could downsize felt that little adequate alternative housing was available. Also, general potential effects are discussed, such as freed up living space, and issues of intergenerational justice. Thirdly, the paper will look beyond downsizing at other options such as co-housing, creating multiple-generation homes, or taking a lodger. The prevalence of these schemes will be discussed, and their potential highlighted.

1. Background

Energy use in buildings is one of the largest contributors to global and local energy consumption. In the UK, domestic buildings are estimated to be responsible for 26% of total carbon emissions (Palmer & Cooper, 2012). The UK Government established the goal of reducing emissions from homes by 29% by 2020 (DECC, 2009). Energy efficiency improvements in UK homes form a central part of the decarbonisation plans, with millions of retrofits of domestic homes planned over the next decades (UK CCC, 2010). However, a potential driver of domestic energy consumption not covered by Government policy is under-occupancy, i.e. when a household has more space / rooms than it would need. This paper shows the impact of building size on

domestic energy consumption, exemplifies the differences in energy consumption for single-person households with varying numbers of rooms, shows the extent over under-occupying, and discusses benefits, challenges and alternatives to downsizing.

2. Empirical findings

We present data on the importance of building size vs. household size on domestic energy consumption. We then show the amount of over- und under-occupying in the UK, before exemplifying how energy consumption could change if occupants had fewer rooms. We used nationally representative samples from England for data analysis; the Energy Follow-Up Survey (EFUS) and the English Housing Survey (EHS). They collected data about the dwelling and household characteristics and behavior. Gas and electricity meter readings were obtained to estimate annual energy consumption. N = 991 households were analyzed. Correlational analysis was used to understand the relationship between energy consumption, dwelling size, and occupancy. Regression analysis tested the impact of the different predictors on (log-transformed) annual energy consumption. Selecting subsamples of the data set, we showed the impact of living in a larger then needed property.

2.1.1. The effect of building size

The correlation between building size, measured in m^2, and energy consumption (kWh) was $r = .49$. The correlation between household size and energy consumption was $r = .34$. Only a weak correlation existed between household size and building size of $r = .27$. Then, linear regression was carried out. For a model only encompassing dwelling size, the $R^2 = 25\%$; i.e. 25% of the variability in energy consumption is explained by building size. Adding dwelling type, increased the amount of explained variability to adjusted $R^2 = 29\%$; $F(5, 985) = 84.34$, $p < .001$. A model only using household size as a predictor explained 11% of the variability in energy consumption. A combined model using house size, dwelling type, and household size showed an adjusted $R^2 = 33\%$; $F(6, 984) = 82{,}86$, $p < .001$. Table 1 shows unstandardized coefficients and their standard error (B, SE) and standardized (β) regression coefficients. Note that despite the moderate correlation between household size and floor area, there was no issue of multicollinearity (all VIF < 1.6).

Table 1. Regression coefficients and standard errors (B, SE, β). *** indicates significance at <.001

Predictor	B (SE)	β
Dwelling size (m2)***	0.005 (< 0.000)	0.357
Dwtype (Ref= Detached): Flats***	-0.351 (0.057)	-0.223
Dwtype: EndTerrace	0.029 (0.055)	0.016
Dwtype: MidTerrace	-0.067 (0.050)	-0.046
Dwtype: Semi-detached	0.026 (0.043)	0.021
Household size***	0.089 (0.012)	0.199

Hence, the analysis as above clearly shows that dwelling size has by far the largest impact on domestic energy consumption, with a standardized coefficient being about 70% higher than that of household size. Flats use significantly less energy than detached houses. A full regression – for brevity not included in this paper (see Huebner et al., forthcoming) – shows that when controlling for a range of other building-related variables, the basic finding stays the same: Dwelling size trumps all other factors.

2.1.2. Over- and under-occupying

The correlation between how many bedrooms a household has and how many it needs to meet its minimum requirements was only $r = .33$, indicating that a large share of households have more or fewer rooms than defined under the bedroom standard (ONS, 2014) as actually being needed. The DCLG (2013) reports that the overall rate of overcrowding in England in 2011-12 was 3%. Overcrowding rates differed considerably by tenure: 1% of owner occupiers, 7% of social renters, and 6% of private renters were overcrowded. Around 8.0 million households were estimated to be under-occupying their accommodation in 2011-12, i.e., they had at least two bedrooms more than they needed according to the bedroom standard. Around half (49%) of owner occupiers were under-occupying compared with 16% of private renters and 10% of social renters. A further 7.7 million households had one bedroom more than they needed under the bedroom standard. It is noteworthy that the bedroom standard sets out minimum criteria: A separate bedroom is allowed for each married or cohabiting couple, any other person aged 21 or over, each pair of adolescents aged 10-20 of the same sex and each pair of children under 10. However, even if 'granting' one spare bedroom, then still 8.0 million households, 36% of the population would be under-occupying.

2.1.3. Example of potential for downsizing

For ease of communication, we exemplify the effect in terms of number of bedrooms in the subsample of all homes with a single occupier. Figure 1 shows how average annual energy consumption varies with the numbers of bedrooms, calculated with the EHS data. Data show an approximately linear relationship; for each additional bedroom, energy consumption increases by roughly 3750 kWh.

Figure 1. Annual energy consumption per number of bedrooms in a single-person household.

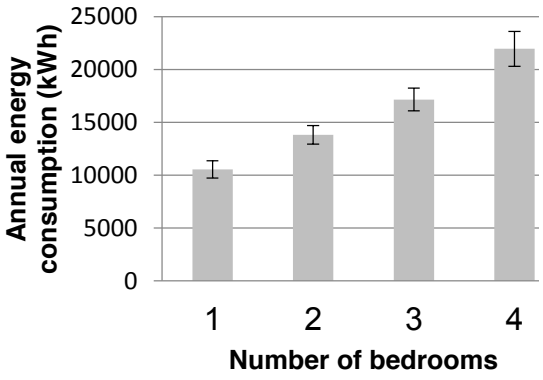


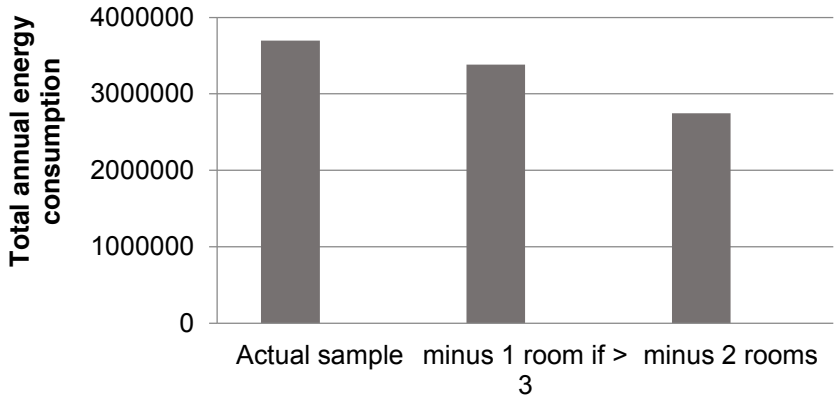
Table 2 shows how what share of single-households have how many bedrooms, in the actual sample, and in two downsizing criteria.

Table 2. Prevalence of number of bedrooms in sample and scenarios.

No bedrooms	Energy consumption (kwH) p.a.	% in sample	% if those with 3 or more rooms downsized by one room	% if all downsized by two
1	10548	24.12	24.12	95.72
2	13809	41.25	71.6	4.28
3	17159	30.35	4.28	
4	21947	4.28		

Figure 2 shows the changes in the sum of annual energy consumption for all single-person households in the actual sample and the two downsizing scenarios.

Figure 2. Total annual energy consumption in the different cases.



Hence, even a very lenient downsizing would result in an energy reduction of 8%, and reducing by two rooms to a reduction of about 25% in energy consumption in the sample of single-occupancy households. Of course, this analysis has limitations; it does not account for differences in, for example, building quality, and is based on a sample with only with a limited number of cases (N = 257 single-person households). But even assuming a wide error margin, this would still be a significant reduction, and illustrates the potential for energy savings through downsizing.

3. Issues around downsizing

3.1. Benefits of downsizing

Given the national targets of reducing energy consumption, one obvious benefit would be lower energy consumption if downsizing were to be realized. A complete and detailed analysis of the energy saving potential is beyond the scope of this paper; however, the example as above illustrates the potential for significant reductions in energy consumption. If underoccupying and overcrowding balanced each other, redistribution of housing would not result in energy savings; however, given that under-occupying is so much more prevalent than overcrowding, there is presumably a huge potential for energy savings if alternative, smaller housing was available. Other benefits include a greater availability of housing stock for the younger population, i.e. larger properties for families and more properties if existing large dwellings were converted into multiple living units. Whilst, as evidenced above, the overall amount of overcrowding is currently limited in the UK; this is not true for

cities such as London where overcrowding is a significant issue; in particular in families with children. Estimates vary, but it is estimated that around a quarter of families in London experience overcrowding[1], and 11% of all households (ONS, 2014). The housing crisis, i.e. a lack of available, appropriate properties, and high housing costs, is often seen as a core issue of intergenerational justice (Morton, 2013). A redistribution of housing would be a huge step forward; given that the majority of households are under-occupying, in the case of London roughly 50% (ONS, 2014). A further benefit for those downsizing is the possibility of moving to more age-appropriate housing, e.g. without stairs, with wide doors, and in close proximity to amenities or public transport. In fact, research showed that bungalows are the preferred housing option (Ipsos Mori, 2002). Also, a smaller property with a smaller or no garden allows for easier maintenance. Downsizing could also significantly increase the disposable income of householders, through lower rent and/or lower bills and by freeing up substantial capital[2] for home owners.

3.2. Challenges of downsizing

One challenge relates to the non-availability of appropriate housing: Whilst bungalows were the preferred choice, only very few of them are currently built. New flats that dominate the new-builds are only popular with 1% of the elderly population. In general, there are too few one or two-bedroom properties. In recognition of the problem of under-occupying, Government had introduced the “under-occupancy charge”, better known as bedroom tax in the UK, to penalize social housings tenants who have more bedrooms than needed. Occupants lose a share of their entitled benefits for occupying more space than deemed necessary. However, this scheme has been highly criticized because of the lack of alternative housing to which tenants could move in order to avoid the penalty. Research has also shown that people are concerned what to do with their possessions when moving to a smaller home and have expressed the need to have spared bedrooms for visiting children and grandchildren (Leach, 2012). Possible other factors are the considerable inconvenience and the costs of moving, and – if deciding to downsize to a rented accommodation – the loss of ownership.

4. Alternatives to downsizing

Taking a lodger would be an alternative; and indeed, schemes that exist that bring benefits beyond monetary gains such as promoting intergenerational justice and easier maintenance. Germany, for example, has a scheme called “Wohnen fuer Hilfe”[3] (“Living for help”) where students or apprentices live (almost) free of charge in a household of an elderly person but provide other support in exchange, such as shopping, household chores, and companionship. The UK and other countries have similar schemes. Also, a pilot scheme was designed in London, the Redbridge “Free Space” project in which property owners leave their house to move to a smaller, more appropriate housing, but retain ownership of their house. The dwelling is rented out by the Council who takes care of all landlord responsibilities.[4]

5. Implications

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[1] http://england.shelter.org.uk/news/previous_years/2011/july_2011/1_in_4_london_children_overcrowded
[2] http://www.moneywise.co.uk/news/2015-01-23/downsizing-to-semi-detached-could-free-120k
[3] http://www.hf.uni-koeln.de/wfh.php?id=30203
[4] http://www.ilfordrecorder.co.uk/news/redbridge_scheme_for_older_homeowners_hailed_by_housing_minister_1_1180475

Data clearly show how building size dominates domestic energy consumption and that a large number of English households are under-occupying. If more householders would downsize, significant energy savings could be achieved, contributing to the national goal of carbon emission reduction. Other benefits would include freeing up living space for the younger generation, creating more disposable income and more age-appropriate living conditions. Existing policy interventions targeting the social housing sector simply don't work because of the lack of alternative accommodation. In particular in large cities, the lack of availability of housing is significant problem. However, given the much higher prevalence of under-occupying than overcrowding, redistribution of housing together with converting existing housing into smaller living units could have a huge impact. Apart from logistic issues, a pure redistribution might not cover other issues, such as allowing living in a bungalow or the desire to have space for visitors. Developing buildings solutions that turn large properties into smaller desired living units that are then designed to e.g. have wide doors and mobility aids at stairs are an idea. Additionally, it might be an incentive to have a shared space for visitors, i.e. a "guest house" for those living in a community. Also, the idea of home share could be promoted much more.

Finally, more rigorous research is needed to understand what incentives and hinders downsizing, and ideally use a stringently designed randomized control trial to test actual downsizing rates.

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