The NIMBY coalition: are there predictors of opposition to housing?

With the UK housing market crisis drawing increasing attention to those who oppose housing (NIMBYs; not-in-my-back-yard), this explorative research note examines the prevailing narrative about the group being predominantly older, rural-dwelling and of certain political persuasions. It investigates whether and how much these characteristics relate to the percentage of planning permission applications granted in local authorities across England. Findings include that age and ruralism do not have as great an effect as suggested, while politics does. However, due to violations of some assumptions of multiple linear regression, results should be regarded cautiously.

Introduction and background

Housing has become an increasingly salient topic to voters in the UK in recent years. The 2008 financial crisis led to the repossession of thousands of homes (Department for Housing, Communities and Local Government, 2014) and due to quantitative easing aimed at bolstering the economy and housing market, precipitated unusually low interest rates in the decade following (Cukierman, 2013). Since 2013, housing demand has been encouraged with the government's help to buy loan scheme for first time buyers, and during the COVID pandemic with the temporary abolition of stamp duty. That said, housing has been increasingly difficult for people to secure of late; 'real house prices in the UK have almost quadrupled over the past 40 years, substantially outpacing real income growth', according to the Bank of England (Miles & Monro, 2019). The Office for National Statistics (ONS; 2023b) found that house prices relative to average earnings are currently near all-time highs. Where houses cost on average 3.5 times the median salary in England in 1997, this rose to 8.3 times in 2022. This is greater in areas of high demand, such as London and the South East (for example, Camden and Windsor & Maidenhead Local Authorities had affordability ratios of 18 and 14.2 times median earnings, respectively). As a result, Lamont (2023) found, houses have not been this unaffordable since Victorian England.

This steep rise in house prices relative to earnings and the resultant decrease in affordability has changed the demographics of housing tenure in the UK. First time buyers tend to be older than they historically have been and the majority of houses owned outright are owned by those age 65+, (ONS, 2023b). Moreover, the majority of those under 34 are renters, and are feeling the brunt of this affordability crisis, too. Rents in the UK reached record highs in Q1 of 2023, with an average of £2,501 in London and £1,190 outside of London (Rightmove, 2023). However, rising rents have not corresponded to the quality of rental properties improving (Spratt, 2022).

One of the root causes of the housing crisis, and the problems that stem from it is simple supply and demand (Kyriakou, 2022; Koster & Zabihidan, 2019). While government policies have increased demand for housing in recent years by artificially suppressing prices through stamp duty holidays and low interest rates, supply has not increased enough to keep up with that demand (Reisenbichler & Wiedemann, 2022).

The Centre for Cities (Watling & Breach, 2023) estimates that due to insufficient housebuilding, the UK currently has 4.3 million homes fewer than it needs to have to catch up with the average European country. They estimate that to catch up with those countries would entail building around 650,000 homes per year for the next 10 years. Part of the reason for this shortage, the CfC contends, is the Town and Country Planning Act of 1947. The TCPA made planning less flexible and gave local communities more power over what got built in their area. Though this sounds positive and democratic, it has arguably led to local communities having *too much* power over planning decisions, blocking developments for trivial reasons (Cheshire, 2014). Such groups of people have been dubbed 'NIMBYs' or 'BANANAs' ('not-in-my-back-yard' and 'build absolutely nothing, anywhere, near anything').

Debates about increasing housing supply are often framed as a generational issue (for example, Holleran, 2021) and reporting on NIMBYs and BANANAs tend to portray them as being older, rural-dwelling and Conservative or Liberal Democrat leaning (for example, Lees, 2022).
Reasons given by NIMBYs for opposing developments often relate to concern for the resilience of local public services, loss of green space and the wildlife within it, and concern about overdevelopment (see Coward, 2021). More cynically, some have suggested that NIMBY-ism originates from a concern that a greater supply of houses in one's area will drive down the value of one's own home (Pleace, 2023). As 36% of the UK's total household wealth is held in property, this is a reasonable assumption to make (ONS, 2022a).

Though the importance of housing tenure as a predictor of political beliefs has been highlighted by some, for example, being linked to likelihood of voting for Brexit (Ansell & Adler, 2019) and opposition to trade openness (Scheve & Slaughter, 2001), political science literature on housing is still relatively thin. Ansell & Adler (2020) suggested that the higher likelihood of voting for Brexit among homeowners was related to their local identity and sense of place, which they felt the EU (and migrants from the EU) were infringing upon. While Harrison (2019; 61) notes that rural opposition to housing does, in some instances, stem from a desire to keep the 'wrong kind of people' out, the developments studied faced opposition from across the social spectrum. Reasons for opposition can include gentrification, fear of displacement of existing residents, 'community balance and social capital' and sustainability of local areas (Gallent & Robinson, 2011). However, as Harrison (2019) notes, though opposition cuts across social spectrum in rural areas, motivations can differ depending on whether the individual is a long-time resident or someone with a second home.

Ansell & Cansunar (2021) touch on homeownership in a time of increasing unaffordability, noting that 'homeowners may seek to protect their windfalls from… the indirect threat of new construction'. That is, they oppose new development to prevent increased supply of housing pushing down the value of their own home. Where the majority of those who own their homes outright are in the 65+ age category (ONS, 2023b), it would follow that these are the group most likely to oppose new housing. Moreover, Ansell (2014) has demonstrated that owning a home decreases redistributive attitudes, increasing the likelihood that homeowners will vote against a party with redistributive policies such as increased welfare and provision of social housing. As there is a link proposed between homeownership and the desire to protect the value of the home, this could explain the perception that a significant proportion of NIMBYs are Conservative voting.

However, there is still relatively little research into NIMBY-ism and the determinants of opposition to housing in the UK, meaning we rely on anecdotal evidence like that mentioned above, and links between the tangential spheres of housing, politics and rural/urban studies literature. No research has accounted for these characteristics in concert when all are deemed important factors of NIMBY-ism by the prevailing narrative.

In this paper, I will operationalise the characteristics mentioned above (age, ruralism and politics), using a multiple linear regression to explore whether, and how well they meaningfully affect opposition to housebuilding. The wider narrative around NIMBY-ism would suggest that control of a local authority by the Conservative or Liberal Democrat parties will have a negative effect on the percentage of planning applications granted. I would expect this to be greater for major developments than minor developments. Based on the above, I would expect both median age and ruralism to have a negative effect on percentage of applications granted, and for this to also be stronger for major than minor developments. As this research is exploratory and there is little solid prior literature on opposition to housebuilding, these hypotheses are tentative.

Data and sources

To operationalise opposition to planning, I will use the percentage of planning permission applications granted by each Local Authority (LA) between the years 2014-2022, taken from the Department for Housing, Levelling Up and Communities' open data portal (DHLUC, 2023). LAs with a lower percentage of planning permission approvals are taken to have more 'NIMBY' tendencies. As some LAs were split up or merged during this time, I will only use LAs whose boundaries did not change, leaving 292 LAs of 333. This data is for England only.

Data for the number of planning applications granted is sorted into minor and major developments (consisting of between 1-9, and 10+ dwellings, respectively). As it would be interesting to see if the characteristics of interest mentioned above have a different effect on applications granted by size, I will be using both minor and major application datasets. I will also combine these to estimate the effect of said characteristics on total applications granted. For all three (minor, major and total), I will standardize the data by taking the percentage of applications granted, not the number.
To explore those characteristics stereotypically ascribed to NIMBYs, I will use data from a number of sources. For age, I will use each LA's median age from the ONS mid-year estimates for each respective year (ONS, 2022b). For ruralism, I will use the Department for Environment, Food and Rural Affairs' percentage of the population living in a rural area for each LA (DEFRA, 2011; there has not been an update since the 2021 Census). There is no annual estimate for the percentage of population living in rural areas in each LA, meaning that the model will be unable to take into account changes in ruralism over time.

For party control, I will use the council control of each LA, taken from an independent elections analyst (Open Council Data UK, 2023). Where there is 'No Overall Control' of a council, I will take the largest party. I have excluded any Local Authority where control was held by UKIP or the Green Party, as these parties held very few councils in the period in question, meaning they would be an outlier. The parties included in the analyses are the Conservatives, Labour, Liberal Democrats, Independents and Nationalist and Local parties.

The Nationalist and Local category (denoted by 'Nat' in the data) consists of nationalist parties like the SNP and Plaid Cymru, and local residents' association parties. As there are no Scottish or Welsh LAs in the planning permissions data used for this research note, these are confined to local parties. An example of this is in Castle Point local authority in Essex, where the Canvey Island Independent Party and the People's Independent Party have joint control of the council. This is a particularly useful distinction to make, as the specificity of these parties to local areas may mean that local authorities controlled by them are more responsive to local views about potential housing developments. I would expect control of a council by a Local party to have a negative effect on percentage of planning applications granted.

Estimation and results

Estimation

I will be using multiple linear regression to estimate the effect of characteristics mentioned above on percentage of planning applications granted. The model will be specified as follows:

$$Y = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \varepsilon$$

Where for each LA, Y is percentage of planning permission applications granted; X_1 is party control; X_2 is median age and X_3 is ruralism (represented by the percentage of the population living in a rural area).

That is:

$$Y = \alpha + \beta_1(party\ control) + \beta_2(median\ age) + \beta_3(ruralism) + \varepsilon$$

Here, the coefficients β_n represent the relationship between the percentage of applications granted in an LA and the respective demographic characteristics said to affect said level of support for development. As planning applications for dwellings are sorted into minor and major, I will run this model for minor, major and total developments to explore if there is a difference in the effect of these variables on percentage of applications granted depending on the size of the proposed development. The parties of most interest for this model are the Conservative and Liberal Democrat parties. I am also interested in the effect local party and independent control of councils will have on percentage of applications granted, so will make the Labour party the reference category for party control. Further information on choices made in model specification can be found in appendix A.

Results

The specified models were tested to check whether they satisfied the assumptions of multiple linear regression (see appendix B). A Breusch–Pagan test confirmed that the models violate the homoscedasticity assumption, therefore, to obtain robust standard errors I performed a t-test for the estimated coefficients in the models. The results of these are reported in table 1, below.

This shows that increasing ruralism does have a significant (but small) effect on the percentage of minor and major planning permission applications granted, but not on the total percentage of applications granted. For minor developments, this effect is slightly positive, whereas for major developments, it is negative (as expected). As a one unit increase in ruralism would result in a 0.016% increase and 0.027% decrease in developments approved for minor and major developments respectively, none of these coefficients would noticeably affect the percentage of applications granted in the median local authority.

Similarly, median age has a significant but minimal positive effect on the percentage of planning applications approved for developments for all and minor developments. Again, these coefficients would likely have a relatively small impact on the median authority, with a 1 unit increase in median age resulting in a 0.357% and 0.395% increase in applications approved for total and minor developments, respectively. The direction of the relationship between median age and percentage of planning applications granted is opposite that expected for both total and minor developments. This suggests that as the median age in a local authority increases, the percentage of applications granted will also increase – though by relatively little. The effect of age on percentage of *major* developments granted permission is negative (the expected direction of the relationship) but non-significant and of a negligible size, meaning nothing of note can be inferred.

Conversely, political party has a significant and noticeable effect on the percentage of planning applications approved. Compared to Labour – the reference category for the party variable in these models, local authorities where any other party has a majority or plurality of seats (and thus control or greater influence over the local planning authority) approve a significantly lower percentage of developments. Interestingly, this is particularly true of councils where Independents have a majority or plurality. While Conservative and Liberal Democrat majority/plurality local authorities do show a significantly lower percentage of planning applications granted (by around 5% less for all developments for both parties), their relationship is still markedly less negative than that of Independent majority/plurality authorities, who approve between 9.84% and 12.34% fewer homes than Labour authorities. Reasons for this will be considered in the discussion below. The

Table 1: t-test of fitted regression coefficients

	Dependent variable:		
	Total granted (1)	Minor granted (2)	Major granted (3)
Ruralism (%)	0.011	0.016^{*}	-0.027^{***}
	(0.006)	(0.006)	(0.007)
Median age	0.357^{***}	0.395^{***}	-0.002
	(0.045)	(0.046)	(0.051)
Liberal Democrat	-5.082^{***}	-5.129^{***}	-4.876^{***}
	(0.647)	(0.668)	(0.744)
Conservative	-5.119^{***}	-5.190^{***}	-5.099^{***}
	(0.379)	(0.391)	(0.436)
Independent	-9.837^{***}	-9.639^{***}	-12.344^{***}
	(1.315)	(1.359)	(1.513)
Local party	-3.399^{***}	-3.420^{***}	-3.236^{***}
	(0.847)	(0.875)	(0.975)
Constant	71.291^{***}	69.273^{***}	89.933^{***}
	(1.699)	(1.756)	(1.954)
Note:			$^{*}p<0.05$; $^{**}p<0.01$; $^{***}p<0.001$

effect of Local party control on the percentage of planning applications granted by a local authority was also negative, but less so than for other parties, indicating between 3.2% and 3.4% fewer approvals than Labour for total, minor and major developments.

Discussion and conclusion

Discussion

As expected, Conservative and Liberal Democrat council control has a significantly negative effect (compared to Labour) on the percentage of planning applications granted. However, unexpectedly, in both cases the effect was stronger for total and minor developments than for major – though not by a lot. As the effect on percentage of planning permissions granted is negative across the parties compared to Labour it is difficult to determine the specific mechanisms driving the implied opposition to development. Whereas Ansell (2014) and Ansell and Cansunar (2021) linked homeownership to voting against redistribution (i.e. Conservative) and to a desire to preserve the value of one's home by opposing more housing, it is unclear what drives the effect that Liberal Democrat local authority control has on applications granted. Future research could address this.

Local authority control by Independents is estimated to have the most negative effect on percentage of applications granted, compared to Labour. However, I would suggest that this is not because they are necessarily opposed to building housing, rather because Independents do not associate with any party (therefore are not whipped to vote a certain way) and usually hold a wide range of ideologies between them. As a result, local authorities where Independents have a majority or plurality likely lack the political cohesion required to organise any sort of strategy or consensus around planning.
The positive effect of median age on planning applications granted was also unexpected (though small). Older people are more likely to own their own home and as Ansell and Cansunar (2021) suggested, are motivated to protect the value of that asset, I had expected age to have a negative effect on applications granted which was not the case. Similarly, ruralism had a relatively minor effect on the percentage of planning applications granted, which is also counter to the prevailing narrative, and the 'unusual, if not unique, attitude towards rural development in the UK' (Sturzaker, 2011). It is possible a more significant effect was not found for ruralism because it was not possible to account for differing rates of ruralism over time.

However, these analyses had a number of limitations that affect the validity of the above findings. Firstly, the violation of the homoscedasticity function means that there is uncertainty around the fit and accuracy of the model, leading to increased risk of type 1 errors (Astivia & Zumbo, 2019). Though this was addressed by calculating robust standard errors, it is possible this method was unable to address the violation adequately, given that autocorrelation also increases the risk of type 1 errors (Gujarati & Porter, 2009). Unfortunately, the source of these violations may be the nature of the research question itself; no quantitative research has accounted for these characteristics together when all are thought to be factors of NIMBY-ism, probably because it would be difficult to sufficiently disentangle their effects, as found in this research note.

These models' violation of or questionable qualification for some assumptions of multiple linear regression means that their explanatory power is limited (this is expanded upon in appendix A). This could potentially be addressed through exploring different configurations of the models, including with different variables or interaction terms. That said, it remains that the variables used in the above models were likely linked, and thus limitations on explanatory value were somewhat expected. This could, to an extent, be mitigated by a more considered choice of variables, or how variables were specified but it is unlikely that the problem would be resolved entirely.

Additionally, most opposition to housing occurs at lower geographies than local authority (e.g. Harrison, 2019; Davison et al., 2013). Though local authority planning offices are the ultimate arbiters of whether a planning permission application is approved, resistance to development is often organised at ward, parish or county council level. As a result, the data used in this research note are likely not granular enough to provide a sufficiently clear picture of how the relevant characteristics shape opposition to housing. Due to limitations in DHLUC's data collection, local authority level was the smallest geography where the data for all predictors was also available. Future research could address this, as it would allow the inclusion of smaller parties like the Greens and UKIP/Reform, however gathering data for planning permissions approved at lower geography levels would be labour intensive.

There are also a number of factors external to the model that were difficult to account for, chiefly, the effects of austerity on local authority planning budgets, which has been noted in the media (Ellson & Wright, 2023). Where the percentage of planning permissions approved has decreased in recent years in some local authorities, it is not clear whether this truly was influenced by the increasing prevalence and salience of NIMBYism or simply because those authorities did not have enough capacity to process applications received. Other external factors that could affect the percentage of planning permission applications approved include the economic climate – which was worsening towards the end of the period in question, the COVID-19 pandemic, and government policy, described as a "NIMBY charter" by the media (O'Connor, 2010).

Conclusion

In the midst of a housing crisis that sees the median first-time buyer pay more than eight times their salary on their first home, and sees renters increasingly spend upwards of 30% of their monthly income on rent, it is increasingly important to understand the drivers of opposition to building more housing. This paper set out to explore whether the prevailing narrative that older, rural-dwelling people of certain political persuasions have a significant effect on the rate of developments is true. It found that, though significant, the effect of age and ruralism on percentage of planning applications approved was relatively minimal. Party was found to have a significant effect, with local authorities controlled by Independent politicians unexpectedly having the most noticeable negative effect. However, this was more likely due to a lack of political cohesion and consensus around housebuilding among Independent politicians than NIMBY-ism. A further extension of this research could be to investigate the effects of local party cohesion on planning application approvals.

As expected, Conservative and Liberal Democrat control also had a negative effect on percentage of planning applications approved. That said, violation of some key assumptions of multiple linear regression mean these results should be regarded particularly cautiously, as these violations likely affected the models' accuracy and reliability. It is thought this is in part due to the limited granularity of the data meaning variables could not be specified as precisely as desired, as well as the nature of the analysis, dealing with variables (age, ruralism, politics) that are likely to co-occur in certain combinations. Future research could address this by using more granular data, hopefully enabling a better distinction between variables, as well as the ability to include smaller parties in analyses.

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Appendices

Appendix A – Model specification and choices made

Median house price

It was suggested by Ansell & Cansunar (2021) that those who already own homes are motivated to protect the value of their assets. To test this, I specified the model below:

$$Y = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \varepsilon$$

Where for each LA, Y is percentage of planning permission applications granted; X_1 is party control; X_2 is median age; X_3 is ruralism; X_4 is median house prices:

$$Y = \alpha + \beta_1(party\ control) + \beta_2(median\ age) + \beta_3(ruralism) + \beta_4(median\ house\ price) + \varepsilon$$

The above model improved the adjusted R^2 notably, however the model constants were unusually high, suggesting that the model had significant problems. Moreover, a residuals vs fitted values graph produced using the plot() function showed high variance in residuals – beyond that seen in the models used in the paper. Ultimately, this variable, though interesting to include, was not essential and was therefore omitted.

Fixed effects

Time

As the data used in this research note is across nine years, I explored using time fixed effects to eliminate bias from unobservable variables that change over time but remain constant between LAs.

$$Y = \alpha + \beta X_1 + \beta X_2 + \beta X_3 + \gamma_1 D_1 + \gamma_2 D_2 + \cdots + \gamma_{n-1} D_{n-1} + \varepsilon$$

Here, for each LA, Y is percentage of planning permission applications granted; X_1 is party control; X_2 is median age; X_3 is ruralism. Time fixed effects are denoted by the dummy variables $D_n \dots D_{n-1}$ (where $n-1$ represents the number of levels of the dummy variable, minus the reference category; and γ, the coefficient). However, when put into practice, the time fixed effects had a high variance inflation factor of 8, meaning its inclusion in the model could cause bias. Moreover, inclusion of time fixed-effects did not noticeably change the size, or significance of other variables' coefficients. As a result, I did not include time fixed effects.

Place

Equally, to eliminate bias from unobservable variables that change between places but remain constant over time, I also explored adding place (local authority) fixed effects when deciding what model to fit.

$$Y = \alpha + \beta X_1 + \beta X_2 + \beta X_3 + \gamma_1 D_1 + \gamma_2 D_2 + \cdots + \gamma_{n-1} D_{n-1} + \varepsilon$$

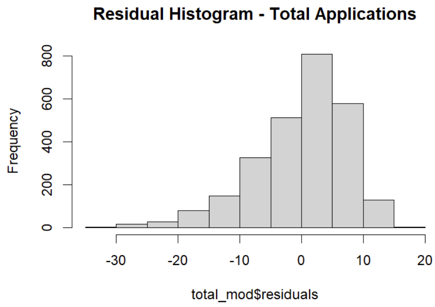
Here, for each LA, Y is percentage of planning permission applications granted; X_1 is party control; X_2 is median age; X_3 is ruralism. Place fixed effects are denoted by the dummy variables $D_n \dots D_{n-1}$ (where $n-1$ represents the number of levels of the dummy variable, minus the reference category; and γ, the coefficient).
Unfortunately, this also had a high generalised variance inflation factor, suggesting high collinearity with other variables, reflecting that Local Authority was an 'alias variable' for ruralism, and the model would perform particularly poorly with both included. As ruralism was one of the key characteristics I set out to test, I decided to also omit place fixed effects.

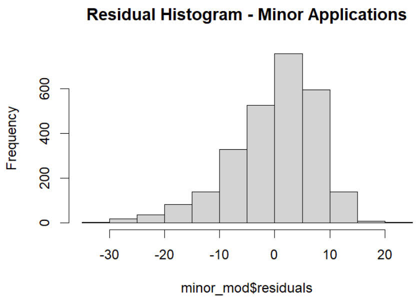
Appendix B – Checking assumptions for multiple linear regression

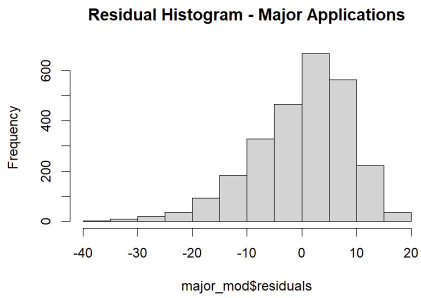
As there are certain assumptions data and models need to meet for this method to produce reliable and robust estimates, I will test those below.

Normality

The below histogram shows the distribution of residuals for the three models included in the above analyses:



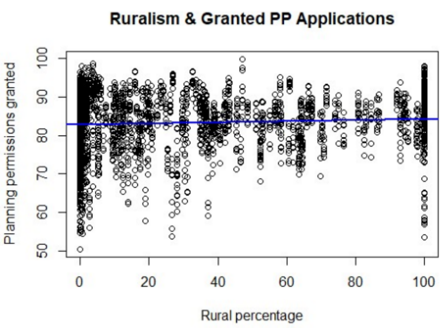


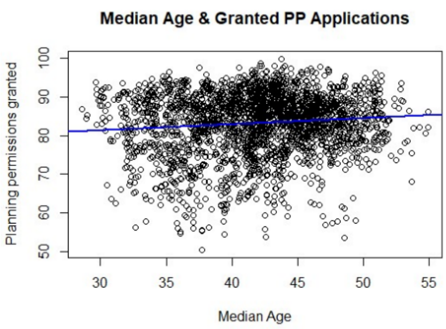


These plots show that though the residuals of the three models have a normal distribution shape, they are slightly skewed. This means that errors may not be randomly distributed, or consistent across observations. As a result, the models fitted may not be the best for the data. Though multiple configurations of models were considered to achieve the best fit, some of those that gave the highest adjusted R^2 also had indications that they were biased (this is expanded upon in appendix B, below). I settled on the models used in this paper because they represented a balance between goodness-of-fit and potential bias.

Linearity

The scatter plots representing the relationship between percentage of planning applications granted and each continous dependent variable for total_mod are provided below. These show a diffuse linear pattern, but also that it would perhaps be beneficial to explore other forms of model or configurations of the below variables.

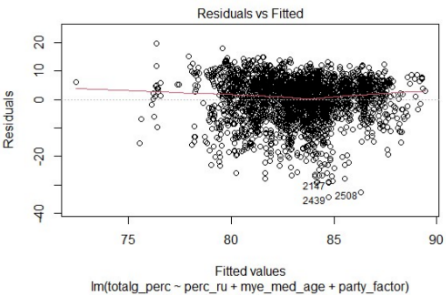




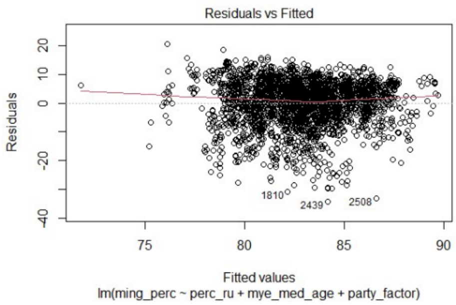
Homoscedasticity

To check that errors vary constantly, I used the plot() function for each of total_mod, minor_mod and major_mod to produce a plot of residuals vs fitted values. These show that, though the line fitted to the graph is relatively close to the zero-line, the data points are not particularly evenly distributed about the zero-line – particularly for major_mod, suggesting that the homoscedasticity assumption has been violated.

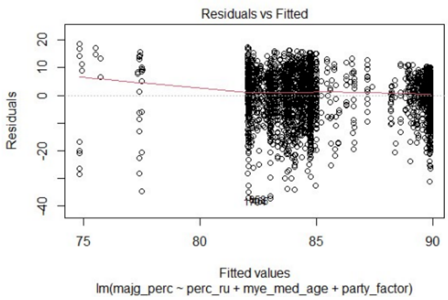
total_mod



minor_mod



major_mod



I verified this with the Breusch–Pagan test, the outputs of which are below, and confirm that these models violate the homoscedasticity assumption, as the p-values suggest that the models are heteroscedastic.

Model	B-P Statistic	Df	p-value
total_mod	78.855	6	0.000000000000006157
minor_mod	86.944	6	<0.00000000000000022
major_mod	140.41	6	<0.00000000000000022

These outputs mean that there is some systemic change in the spread of residuals for the above models, which would increase the variance of the coefficient estimates. As a result, estimates may be less precise, increasing uncertainty around fit and accuracy of the model. Regression methods generally cannot account for the increased variance of coefficients, leading to p-values that are smaller than they should be and increasing the risk of type 1 errors (Astivia & Zumbo, 2019). Longitudinal analyses are particularly prone to heteroscedasticity, where each unit is assessed repeatedly – as local authorities are in the above models. However, heteroscedasticity can also be due to something not accounted for in the model, such as an 'extraneous feature of the research design that makes each observation more related to others than what would be prescribed by the model' (Astivia & Zumbo, 2019). This is likely to be the case with the above models and the predictors used to explain percentage of planning permissions granted, as ruralism, higher age and certain voting patterns are characteristics that often co-occur in certain combinations (and are autocorrelated, as shown in the Durbin-Watson test, below). Heteroscedasticity can be difficult to deal with because ultimately, some data are just prone to non-constant variance (Astivia & Zumbo, 2019).
There are methods to deal with a violation of the heteroscedasticity function including transforming the dependent variables (e.g. taking the natural log), redefining the dependent variables, using a weighted regression, or performing a t-test on the coefficients to derive robust standard errors. As transforming dependent variables has the ability to 'fundamentally change the meaning of the variables' (Astivia & Zumbo, 2019) and would likely be too complicated with four dependent variables, one of which is categorical, I decided to derive robust standard errors using the coeftest() function. These are the numbers shown in table 1 in the main body of text.

Independence
Here I tested the above models for independence of residuals using the Durbin-Watson test. The p-values in the table below suggest there is positive autocorrelation present in each of these models. However, 'one may assume that there is no first-order autocorrelation' if, as per Gujarati and Porter (2009: 436), the DW-Statistic is ≈2. That is, in practice, if the DW-Statistic is not below 1.5, or above 2.5, we can infer that the level of autocorrelation is of less concern.

Model	Lag	Autocorrelation	D-W Statistic	p-value
total_mod	1	0.146	1.708	0
minor_mod	1	0.141	1.719	0
major_mod	1	0.069	1.861	0.002

Nonetheless, positive autocorrelation is indicated, the consequences of which are an inefficient model without the best linear unbiased estimate and wider than necessary confidence intervals, making type 1 errors more likely. A potential source of this in the model is ‘manipulation’ of data, that is, aggregating, interpolating or extrapolating data (Gujarati & Porter, 2009). The example given by Gujarati and Porter is aggregation of quarterly data – this was done with the planning permission applications data used in this research note, so could be a source of the above autocorrelation.

Appendix C – R code, data

Research Note Code & Data

SN: 13809430

2023-07-17

```
## Research note code
## SN: 13809430
rm(list=ls())
options(scipen=999) # turn off scientific notations

setwd("D:/Masters/Y1/1 AQM for SR/Assessment/Research note/Data/Old")
getwd()
list.files()

library(car)
library(tidyverse)
library(stargazer)
library(lmerTest)
library(readxl)
library(lmtest)
library(skedastic)
library(ggplot2)

#nimby data
nimby <- read_excel("nimby_2.xlsx",sheet = "Data")
View(nimby)

#re-leveling factors
nimby$party_factor <- as.factor(nimby$party_2)
View(nimby)
levels(as.factor(nimby$party_factor))
nimby$party_factor <- factor(nimby$party_factor,levels = c("Lab","LD","Con","Ind",
"Nat"))
levels(as.factor(nimby$party_factor))

## Firstly, try w/ and w/o time & place fixed effects
#no FEs
total_mod <- lm(totalg_perc ~ perc_ru + mye_med_age + party_factor + median_hp, da
ta = nimby)
summary(total_mod)
#year FEs
total_yfes <- lm(totalg_perc ~ perc_ru + mye_med_age + party_factor + median_hp +
as.factor(year), data = nimby)
summary(total_yfes)
#local authority FEs
#removed ruralism because it was an 'alias variable' for local_auth, likely collin
earity
total_lafes <- lm(totalg_perc ~ mye_med_age + party_factor + median_hp + as.factor
(local_auth), data = nimby)
summary(total_lafes)

#compare w/ & w/o FEs
stargazer(list(total_mod,total_yfes,total_lafes),
          omit.stat = c("f", "rsq", "ser"),
          omit = c("as.factor"),
          column.labels = c("No FEs","Year FEs", "Place FEs"),
          column.separate = c(1,1,1),
          type = "text",
          digits = 3,
```

```
          no.space = T,
          intercept.bottom = TRUE,
          star.cutoffs = c(0.05, 0.01, 0.001))

anova(total_mod,total_mod2)
anova(total_mod,total_mod2,total_mod3)
car::vif(total_mod)
car::vif(total_mod2)
car::vif(total_mod3)

# Doesn't seem like adding year FEs makes much of a difference to the model
# as ANOVA #1 suggests no sig. diff. and adj R2 very similar. Place FEs does
# increase adj R2 but generalised VIF is very high, so likely to be biased.
# Will therefore omit place/time FEs - will elaborate in RN appendices.

######################
## Main models
##ALL developments
total_mod <- lm(totalg_perc ~ perc_ru + mye_med_age + party_factor, data = nimby)
summary(total_mod)

##MINOR developments
minor_mod <- lm(ming_perc ~ perc_ru + mye_med_age + party_factor , data = nimby)
summary(minor_mod)

##MAJOR developments
major_mod <- lm(majg_perc ~ perc_ru + mye_med_age + party_factor , data = nimby)
summary(major_mod)

#regression table with all models
stargazer(list(total_mod, minor_mod, major_mod),
          omit.stat = c("f", "rsq", "ser"),
          column.labels = c("Total granted","Minor granted","Major granted"),
          column.separate = c(1,1,1),
          type = "text",
          digits = 3,
          no.space = T,
          intercept.bottom = TRUE,
          star.cutoffs = c(0.05, 0.01, 0.001),
          out = 'planning_perms_all.html')

#deal with heteroscedasticity
cet_total <- coeftest(total_mod)
cet_min <- coeftest(minor_mod)
cet_maj <- coeftest(major_mod)

#regression table - coeftest
stargazer(list(cet_total, cet_min, cet_maj),
          column.labels = c("Total granted","Minor granted","Major granted"),
          column.separate = c(1,1,1),
          type = "text",
          digits = 3,
          no.space = T,
          intercept.bottom = TRUE,
          star.cutoffs = c(0.05, 0.01, 0.001),
          out = 'planning_perms_coeftest.html')


######################
```

```
## APPENDICES
## Appendix A - Model specification & choices
## With place FEs - increases Adj R2, but gVIF very high
##ALL developments
total_mod_pfes <- lm(totalg_perc ~ mye_med_age + party_factor + median_hp + as.fac
tor(local_auth), data = nimby)
summary(total_mod)

##MINOR developments
minor_mod_pfes <- lm(ming_perc ~ perc_ru + mye_med_age + party_factor + median_hp
+ as.factor(local_auth), data = nimby)
summary(minor_mod)

##MAJOR developments
major_mod_pfes <- lm(majg_perc ~ perc_ru + mye_med_age + party_factor + median_hp
+ as.factor(local_auth), data = nimby)
summary(major_mod)

#regression table
stargazer(list(total_mod_pfes, minor_mod_pfes, major_mod_pfes),
          omit.stat = c("f", "rsq", "ser"),
          column.labels = c("Total granted","Minor granted","Major granted"),
          column.separate = c(1,1,1),
          omit = "as.factor",
          type = "text",
          digits = 3,
          no.space = T,
          intercept.bottom = TRUE,
          star.cutoffs = c(0.05, 0.01, 0.001))

## Appendix B - Checking Assumptions for the various models
##TOTAL (combined minor/major developments)
hist(total_mod$residuals, main = "Residual Histogram - Total Applications")
plot(total_mod)

#linearity
#ruralism
plot(totalg_perc ~ perc_ru, data=nimby,
     xlab = "Rural percentage",
     ylab = "Planning permissions granted",
     main = "Ruralism & Granted PP Applications")
abline(lm(totalg_perc ~ perc_ru, data=nimby),#adds regression line
       col = "blue", #colour
       lwd = 2.5) #line weight
#median age
plot(totalg_perc ~ mye_med_age, data=nimby,
     xlab = "Median Age",
     ylab = "Planning permissions granted",
     main = "Median Age & Granted PP Applications")
abline(lm(totalg_perc ~ mye_med_age, data=nimby),#adds regression line
       col = "blue", #colour
       lwd = 2.5) #line weight
#party - not continuous
plot(totalg_perc ~ party_factor, data=nimby,
     xlab = "Rural percentage",
     ylab = "Planning permissions granted",
     main = "Party Control & Granted PP Applications")
abline(lm(totalg_perc ~ party_factor, data=nimby),#adds regression line
       col = "blue", #colour
```

```
       lwd = 2.5) #line weight

#independence
durbinWatsonTest(total_mod)

#heteroscedasticity
bptest(total_mod)


## MINOR developments
hist(minor_mod$residuals, main = "Residual Histogram - Minor Applications")
plot(minor_mod)

#homoscedasticity
bptest(minor_mod)

#independence
durbinWatsonTest(minor_mod)


## MAJOR developments
hist(major_mod$residuals, main = "Residual Histogram - Major Applications")
plot(major_mod)

#homoscedasticity
bptest(major_mod)

#independence
durbinWatsonTest(major_mod)
```

Script & data link:
https://www.dropbox.com/scl/fo/mtnij39hfrmvsv0h6lkgq/h?rlkey=ft7rcecmaye75hrz8offu4gpf&dl=0