WHICH CITY IN UK IS THE MOST LIVEABLE?

**ABSTRACT**

In order to find the most liveable city in the UK, we first needed to define a model with all the factors that the majority of people find important. After going through various researcher and conducting our own survey, we came up with twelve factors and their weights.

Then we found data for these factors. We managed to get about 80 UK cities as the number of observations. The database of our choice was MongoDB where most of the cleaning and merging took place. After that, we run the linear regression and tested our factors for their statistical significance and eliminated the ones that were not significant at 5% significance level.

Finally, we combined the estimated coefficients from the regression with our survey weights and got the final weight by which we judge how much each factor is important for determining the liveability of a UK city.

The product of our work is an interactive online application which takes inputs like nationality, age, factor preferences of the users, and suggests the best city to live based on those inputs.

**INTRODUCTION**

Moving to a new city is always challenging! UK has always been a preferred choice for a wide population in all respects, may it be for higher studies, or work, or relocating in general. We, as a group of students who have moved to Southampton recently, came up with an analysis that helps people to decide which is the most liveable city in the United Kingdom. This project aims to find the most preferred city based on chosen factors that most people find important when moving to a new city.

**BODY**

**DATA COLLECTION**

For various factors that determine the liveability quotient of a city, related datasets are required. Various government websites provide data for these factors with respect to the cities in UK. The data has been collected from the following sources:

1. UK Government website
2. Kaggle.com
3. National Health Survey

…and some more.

These datasets provided the data for various cities in UK. But to understand the weights of each factors affecting the liveability, as well as to ensure that the factors collected are realistic, we additionally relied on the following two sources:

1. The Happiness Ranking dataset: This is the dataset from the official government website, which provides the happiness levels of people bases on various factors. The data explains what factors determine people’s happiness, and to what level. For example, *Weather* could be a factor which influences people’s happiness. So, the happiness level would be high for this factor in particular. Therefore, the factors containing the maximum happiness level were chosen.
2. Survey: A survey was conducted on a sample size of 123 people. They were asked to rank each factor from 1 to 10 (10 being the most important), based on their preferences when moving to a new city. The factors are: Flat/House prices, Population, Road Traffic, GVA per worker, Unemployment rate, Noise level at night, Total Jobs available, Weather, Number of schools, Entertainment, Quality of higher education, Number of hospitals, Connectivity to other cities. Being aware of ambiguity and vagueness of some of these factors, we provided a short explanation for GVA per worker and Entertainment in order to help them make a more informed decision. Additionally, Age, Gender, Home Region and Employment Status were collected as well.

**DATA CLEANSING**

For the datasets collected from various government websites, consistency was a major concern. To tackle this problem, we compared all the datasets to confirm if data were available for all the cities, in all the factors. The cities which had no data across all the factors were omitted. As a result, the final count of cities ready for processing was narrowed down to 82.

For the datasets obtained after performing general formatting/cleaning, the normalization process was carried out. The normalization techniques used were Z-score and Min-Max. In some cases, the cities had no numerical data. For instance, when we considered Medical facilities as one of the important factors, the dataset to work with was ‘The Number of Hospitals each city has’. To normalize this data, the Z-score method was used, as we wanted to preserve the range. Similarly, other datasets were normalized as well, based on the type of data. The Min-Max normalization method was used to normalize the weights from the survey. Further analysis was done on the normalized data.

**DATA MANAGEMENT**

The final datasets have been transformed into a different format such as a table-like structure, or a JSON file. Therefore, it was essential to have them all stored in a database for consistent storage. The storage is done on MongoDB, in the form of collections.

**PROCESSING / METHODOLOGY**

For the analysis, we used

1. For selecting the most important factors to work upon, a feature selection technique called Lasso was used. Description of the method:
2. On top of Lasso, we also applied an elimination method that is using F testing and T testing in R. Description of the method:
3. The Linear regression was used to get the estimates and standard errors, as well as, R squared of the whole model. For this, all the datasets were merged and we regressed happiness rating (the regressand/depedent/explained variable) on all of the 12 chosen factors (the regressor/independent/explanatory variables). The result was estimated coefficients and standard errors for each of the 12 explanatory variables. Certain limitations have to be noted here; namely, some of the assumptions of the linear regression might have been violated. More preciously, the zero conditional mean assumption that says that the unobserved factors in the error term should not be dependent on the explanatory variables. However, we are positive to suspect that there might be some factors which we could not have included in the model but which explain the happiness rating and are dependent on the explanatory variables. For example, there were no usable data for crime rates. However, crime rate can explain our “explained” variable to some extent too. A further problem is that the crime rate is correlated with unemployment rate.[[1]](#footnote-1) We also could not find any data for the Environment (tree cover, the amount of green in the city). This is also an issue. In summary, all this means that the estimated coefficient, might be and probably are slightly biased. We also violated the random sample assumption and we might have measurement errors in the reported data we got from the government websites as people tend to overestimate some things and underestimate others as they are filling out government polls. An example of this might be unemployment rate, as people have incentives to alter a bit the information they are filling in in order to get unemployment benefits.
4. For merging the factors and their weights, the Baye’s Decision rule was used.

**APPLICATION**

After performing the analysis, a web application was built, where individual users can interact with the application, and based on the inputs (age, gender…) entered by the user, the most preferable city would be recommended. This recommendation is a result of the analysis carried out by our model.

Another piece of recommendation could also come up from the survey results calculated before. For example, if a user enters a certain age, gender, location, etc., the application could get the data from the survey reports, and would recommend a city that was chosen by people of similar gender/age/location and others.

**RESULT AND CONCLUSION**

As mentioned under the Application section, the result obtained will be two different recommendations, one based on our analysis, and the other one based on similar parameters from the survey conducted before. The estimated coefficient from the linear regression are:

The lasso result is:

**LIMITATIONS AND REFLECTION**

There are a few limitations of the model and our work in general:

1. Most of the datasets are concentrated during the years 2015 and 2016. Since this is only 1-2 year ago, the data collected on our factors should still be representative to a good extent of what is happing in 2017/2018. However, the interactive application can become outdated in the next 10 years as the factors can change much more due to the slowly and ever changing human culture and what things(factors) people are valuing. For instance, it can happen that in the next 10 years, a new extremely effective way of travel is invented and as a result “connectivity to other cities” might become redundant. Another example is with the automation of human jobs, as a result a universal basic income[[2]](#footnote-2) might be introduced and people might to value “total jobs” factor much less in the next years.
2. There were insufficient entries for all factors across all cities. Therefore, the list had to be narrowed down to 82 cities only. This might cause a problem with statistical inferences as we do not have consistent estimators asymptotically and testing (F and T test) is out of question as well.
3. In order to get unbiased estimated coefficient when running a linear regression, 4 assumptions have to be satisfied. Zero conditional mean assumption was most likely violated due to not having all the factors’ data available. For instance, we wanted to collect data for crime rates of each of the city of interest, however, there are no data for this and so the crime is rate is in the error term unobserved, making our estimates biased. The other factors which we wanted to analyse but were not able to are: Environment(Nature), Views or Transport system. The assumption of random sampling was violated too and finally we suspect that some of the data we got might have measurement errors, for instance the population data.
4. For the survey, the sample size for some of the subcategories is too small, and as a result, a bias has to be included in further calculations. Namely, the subcategories that do not have enough observations are:
   1. Age under 18, and over 36
   2. Regions: Africa, Australia, North and South America
   3. The dominant region is Asia (70,7% of all observations), then EU but not UK (16,3%) and UK (6,5%)
   4. For Professional/employment status we have enough observations only for the following three categories: a student (52%), employed for wages (26,8%), self-employed (12,2%). For the others like retired, out of work etc. we do not have enough observations.
5. The application does not have the survey responses for the subcategories that do not have sufficient enough observations.

**REFERENCES:**

**Survey**

<https://goo.gl/forms/dsBcNeAxNLA4QTby2>

**Data sources**

Add the website source for education 2017

<https://data.gov.uk/dataset/noise-exposure-data-england>

<https://www.ons.gov.uk/peoplepopulationandcommunity/housing/datasets/townsandcitiesanalysis>

<http://www.centreforcities.org/data-tool/#graph=map&city=show-all>

<https://www.gov.uk/government/statistics/travel-time-measures-for-the-strategic-road-network-and-local-a-roads-july-2016-to-june-2017>

<https://data.gov.uk/dataset/historic-monthly-meteorological-station-data>

<https://www.theguardian.com/news/datablog/2011/may/19/train-stations-listed-rail>

<https://data.gov.uk/dataset/european-quality-of-life-survey>

<https://www.kaggle.com/getthedata/open-pubs>

<https://www.kaggle.com/PromptCloudHQ/londonbased-restaurants-reviews-on-tripadvisor>

<https://www.timeshighereducation.com/student/best-universities/best-universities-uk>

<https://data.gov.uk/dataset/historic-monthly-meteorological-station-data>

<https://data.gov.uk/dataset/european-quality-of-life-survey>

<https://data.gov.uk/dataset/hospitals_>

<https://www.getthedata.com/open-pubs>

<https://www.gov.uk/government/statistics/travel-time-measures-for-the-strategic-road-network-and-local-a-roads-july-2016-to-june-2017>

**Other sources**

<http://www.bbc.co.uk/news/uk-41203240>

<http://www.independent.co.uk/news/uk/home-news/universal-basic-income-benefits-unemployment-a7939551.html>

I remember we had an article/paper about in Chinese

I remember we had an article that linked happiness and factors and had weights too.

**Blog Post sources**

We have 13 factors:

1. Flat/House prices

2. Population

3. Road Traffic

4. GVA per worker

5. Unemployment rate

6. Noise level at night

7. Total Jobs available

8. Weather

9. Number of schools

10. Entertainment

11. Quality of higher education

12. Number of hospitals

13. Connectivity to other cities

**We have chosen these factors partly based on these blog posts:** ·

* + https://www.domain.com.au/news/what-makes-a-suburb-liveable-the-16-factors-that-make-or-break-a-neighbourhood-20160730-gqhdkw/ : This blog post talks about factors: 1, 3, 13, 9, 10·
  + https://www.ytravelblog.com/makes-place-livable/ : This blog post talks about factors: 8, 10, 3, 1, 5, 7 ·
  + http://theconversation.com/how-do-we-create-liveable-cities-first-we-must-work-out-the-key-ingredients-50898 : 3, 11, 10 ·
  + https://livability.com/best-places/ranking-criteria : 4, 9, 12, 1
  + http://www.city-data.com/forum/urban-planning/1694005-what-makes-city-attractive-young-people.html : 7, 10,
  + https://www.huffingtonpost.com/localeur/what-factors-make-a-city-urban-planning\_b\_5511883.html: 2, 4, 13 ·
  + http://www.agta.asn.au/conf2015/presentations/Chaffer\_L.pdf : this article talks about factors: 8, 6, 13, 10, 12, 9
  + extra source for 55db noise level and why we have chosen this level over others: <http://www.euro.who.int/en/health-topics/environment-and-health/noise/policy/who-night-noise-guidelines-for-europe>

**Article Sources:**

**Extra note:** We were not able to find any academic articles/papers on the following factors or think of any proxies. Nevertheless, we have included those factors because we believe that people consider them when moving to a new city. We believe so because of our survey results and non-academic blog posts which you can find above. The factors are: Road Traffic, Connectivity to other cities.

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**[1] The influence of weather on subjective well-being (happiness)**

Factors note: weather (the amount of rain, temperature)

Source: <https://link.springer.com/article/10.1007/s10902-012-9338-2>

Result: “Women are much more responsive than men to the weather, and life satisfaction decreases with the amount of rain on the day of the interview. Low temperatures increase happiness and reduce tiredness and stress, raising net affect, and high temperatures reduce happiness.”

BibTex:

@article{connolly2013some,

title={Some like it mild and not too wet: The influence of weather on subjective well-being},

author={Connolly, Marie},

journal={Journal of Happiness Studies},

volume={14},

number={2},

pages={457--473},

year={2013},

publisher={Springer}

}

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**[2] Weather and individual happiness**

Factors note: weather (the amount of rain, temperature)

Source: <http://journals.ametsoc.org/doi/abs/10.1175/WCAS-D-11-00052.1>

Result: “Subjective happiness is related to temperature: in a quadratic model, happiness is maximized at 13.9°C. The effects of other meteorological variables—humidity, wind speed, precipitation, and sunshine—are not significant. The sensitivity of happiness to temperature also depends on attributes such as sex, age, and academic department. Happiness is more strongly affected by current temperature than by average temperature over the day.”

BibTex:

@article{tsutsui2013weather,

title={Weather and individual happiness},

author={Tsutsui, Yoshiro},

journal={Weather, Climate, and Society},

volume={5},

number={1},

pages={70--82},

year={2013}

}

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**[3] Climate and Happiness**

Factors note: weather (the amount of rain, temperature)

Source: <http://www.sciencedirect.com/science/article/pii/S0921800904002940>

Result: “Various indices are used for each of these variables, including means, extremes and the number of hot, cold, wet and dry months. Using a panel-corrected least squares approach, the paper demonstrates that, even when controlling for a range of other factors, climate variables have a highly significant effect on country-wide self-reported levels of happiness.”

BibTex:

@article{rehdanz2005climate,

title={Climate and happiness},

author={Rehdanz, Katrin and Maddison, David},

journal={Ecological Economics},

volume={52},

number={1},

pages={111--125},

year={2005},

publisher={Elsevier}

}

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Articles about how flat/house prices, Entertainment, Number of schools, Quality of higher education, number of schools, impact happiness.

Note: Due to the fact that there are no direct studies/academic papers about flat/house price and its impact on happiness. A proxy was used.

**[4] Life Satisfaction and Associated Factors in Older Hong Kong Chinese**

Factors Note: We have chosen living expenses as a proxy for flat/house prices. Participation in social activities is a proxy for Entertainment.

Source: <http://onlinelibrary.wiley.com/doi/10.1111/j.1532-5415.1995.tb07331.x/full>

Result: “Health, adequate income to meet living expenses, and caring relatives were rated the most important factors (>65%). Some of these factors were also those associated with a high life satisfaction score. Factors associated with a life satisfaction score greater than 6 points were higher social class and educational attainment, adequate income to meet living expenses, satisfactory living arrangement, Christianity, good social support, participation in social activities, functional independence, good self-perceived health, good hearing and vision, daily exercise, absence of recurrent falls, and low depressive symptom score.”

BibTex:

@article{ho1995life,

title={Life satisfaction and associated factors in older Hong Kong Chinese},

author={Ho, SC and Woo, J and Lau, J and Chan, SG and Yuen, YK and Chan, YK and Chi, I},

journal={Journal of the American Geriatrics Society},

volume={43},

number={3},

pages={252--255},

year={1995},

publisher={Wiley Online Library}

}

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**[5] Do we really know what makes us happy? A review of the economic literature on the factors associated with subjective well-being**

Factors note: Unemployment as a negative proxy for total jobs available. Separation and lack of social contact as a proxy for population size. Health as a proxy for number of hospitals.

Source: <http://www.sciencedirect.com/science/article/pii/S0167487007000694>

Result: “The evidence suggests that poor health, separation, unemployment and lack of social contact are all strongly negatively associated with SWB.”

BibTex:

@article{dolan2008we,

title={Do we really know what makes us happy? A review of the economic literature on the factors associated with subjective well-being},

author={Dolan, Paul and Peasgood, Tessa and White, Mathew},

journal={Journal of economic psychology},

volume={29},

number={1},

pages={94--122},

year={2008},

publisher={Elsevier}

}

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**[6] The relationship between happiness, health, and socio-economic factors: results based on Swedish microdata**

Factors note: Health as a proxy for the number of hospitals and the noise level at night. Income as a proxy for GVA per capital. Education as a proxy for the number of schools and higher education. Unemployment is the unemployment rate.

Source: http://www.sciencedirect.com/science/article/pii/S1053535701001184

Result: “The results show that happiness increases with income, health and education and decreases with unemployment, urbanisation, being single, and male gender. The relationship between age and happiness is U-shaped, with happiness being lowest in the age-group 45–64 years.“

BiBTex:

@article{gerdtham2001relationship,

title={The relationship between happiness, health, and socio-economic factors: results based on Swedish microdata},

author={Gerdtham, Ulf-G and Johannesson, Magnus},

journal={The Journal of Socio-Economics},

volume={30},

number={6},

pages={553--557},

year={2001},

publisher={Elsevier}

}

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**[7] Crossnational Differences in Happiness: Economic and Cultural Factors Explored**

Factors note: Economic prosperity is a proxy for GVA per capita.

Source: https://link.springer.com/article/10.1023%2FA%3A1006814424293?LI=true

Result: “However, when exploring the independent influence on happiness of either predictors, only economic prosperity persistently correlated with happiness.”

BiBTex:

@article{schyns1998crossnational,

title={Crossnational differences in happiness: Economic and cultural factors explored},

author={Schyns, Peggy},

journal={Social Indicators Research},

volume={43},

number={1},

pages={3--26},

year={1998},

publisher={Springer}

}

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

[]

Factors note:

Source:

Result:

BiBTex:

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

[]

Factors note:

Source:

Result:

BiBTex:

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

[]

Factors note:

Source:

Result:

BiBTex:

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

[]

Factors note:

Source:

Result:

BiBTex:

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

[]

Factors note:

Source:

Result:

BiBTex:

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

[]

Factors note:

Source:

Result:

BiBTex:

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

[]

Factors note:

Source:

Result:

BiBTex:

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

[]

Factors note:

Source:

Result:

BiBTex:

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

[]

Factors note:

Source:

Result:

BiBTex:

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Reference: [↑](#footnote-ref-1)
2. Reference: http://www.independent.co.uk/news/uk/home-news/universal-basic-income-benefits-unemployment-a7939551.html [↑](#footnote-ref-2)