Relation between net rent, net income, construction cost and living space in Germany

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Abstract

Data provided by *Statistisches Bundesamt Deutschland* describing the development of living space [1], population[2], construction cost [3], net rent [4,5] and net income[6] was investigated to find factors influencing rent as well as information about rent development. It was found that in Germany as a whole income seems to increase more strongly than rent. In at least one federal state rent development differs significantly from all other federal states.

Introduction

A lack of affordable housing is an ongoing issue not only in Tübingen, but a large number of german cities. Especially single parents, single pensioners and students suffer from high rent [9]. However, there seems to be a disagreement as to whether the general situation improves or worsens. While in many large cities rent seems to increase more strongly than income [7], the owners' association Haus und Grund claims that income has increased more strongly than rent since 2015 [8, 9]. Factors affecting the development of rent might not only consist of available living space, i.e. an increase or decrease in population as well as the total space used for housing, but also of the material and labor cost for constructing and renovating buildings. This is especially true since in 2015 a minimum wage has been introduced and a shortage of construction materials has been reported during the last years [10].
I will investigate the general trend in the development of net income and net rent within germany as well as search for factors that seem to influence rent development. Moreover, I will check if the rent development of any federal state differs significantly from the other federal states.

Data

All data has been collected from the online database of *Statistisches Bundesamt Deutschland*.

The following data sources have been used:

- The total available living space in qm in germany, 1995 to 2020 [1].
- The total population per federal state, 1995-2020 [2].
- The total construction cost index as well as indices for labor cost and material cost separately. The data is available from 2000 to 2020 for germany as a whole [3].
- The rent index per federal state, available from 2005 to 2020 [4].
- The rent index for germany, 1995-2020 [5].
- The net income in € for germany, available from 2000 to 2020 [6].

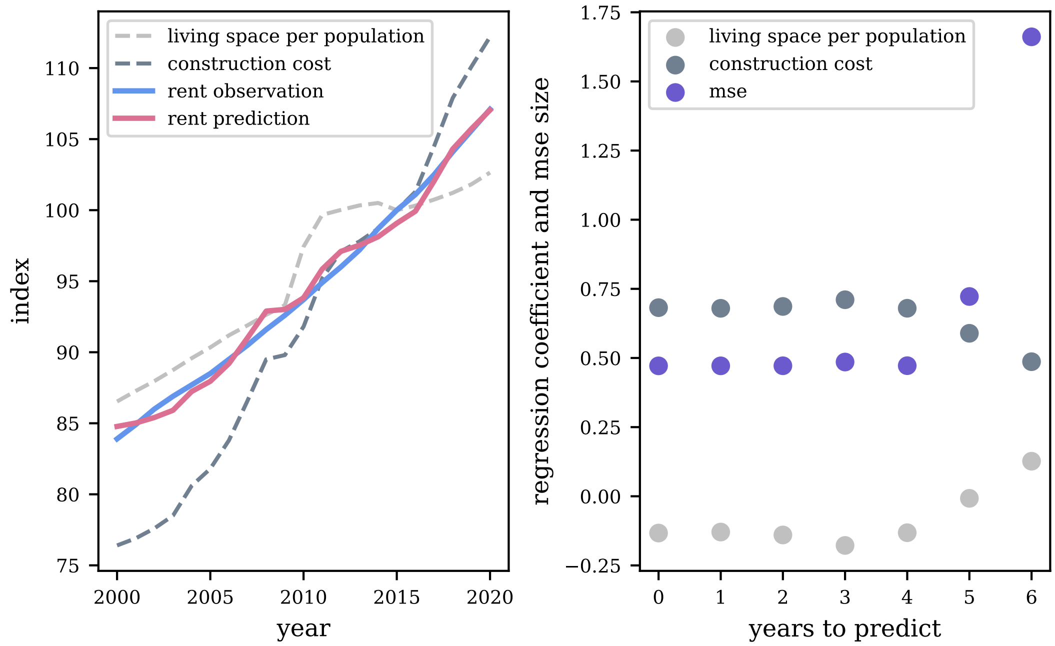

Figure 1: Left: Rent index observation and rent index prediction using the living space per population index as well as the construction cost index as explanatory variables. Right: Regression coefficients and mean squared error if the last x years are predicted instead of learned.

In order to facilitate comparison between features, the living space, total population as well as the net income data are converted to indices as well. This means that for all features the data value for 2015 is set as the 100% baseline and the data represents the percentage change relative to the baseline value. E.g., a rent index of 108 for 2017 describes a rent increase by 8% compared to rent in 2015.

Net income data is missing for the years 2008, 2013 and 2018 and was interpolated. Moreover, the rent index per federal state is missing for Schleswig-Holstein and Hamburg from 2005 to 2014. The missing values were filled by computing the mean over all other federal states per year.

My first approach was to compute a linear regression on the rent index using population size, available living space, labor and material cost as explanatory variables. However, since only 20 years of data are available for all features, the features have to be combined in order to keep the number of degrees of freedom reasonable. Thus, total construction cost instead of material and labor cost was used. A new feature was created by dividing the living space index by the population index and converting the new living space per population feature to an index as well.

Results

Using both construction cost and living space per population as features led to the best rent prediction (MSE: 0.472, Fig. 1, left) compared to using only the living space per population (MSE: 3.98) or construction cost (MSE: 0.512).
The regression coefficient of the construction cost is positive (0.682) while the coefficient of living space per population is slightly negative (-0.133). When utilizing only the first 14-20 years of data for training but predicting on all data points, it can be seen that the construction cost coefficient has increased since 2014 while the living space per population coefficient has decreased and changed from positive to negative (Fig 1, right).

When plotting income index and rent index against each other, it can be seen that the rent index has increased more slowly than income index (Fig. 2, right). Their slope can be approximated using a linear regression with time as the explanatory variable. For the rent index, the regression coefficient

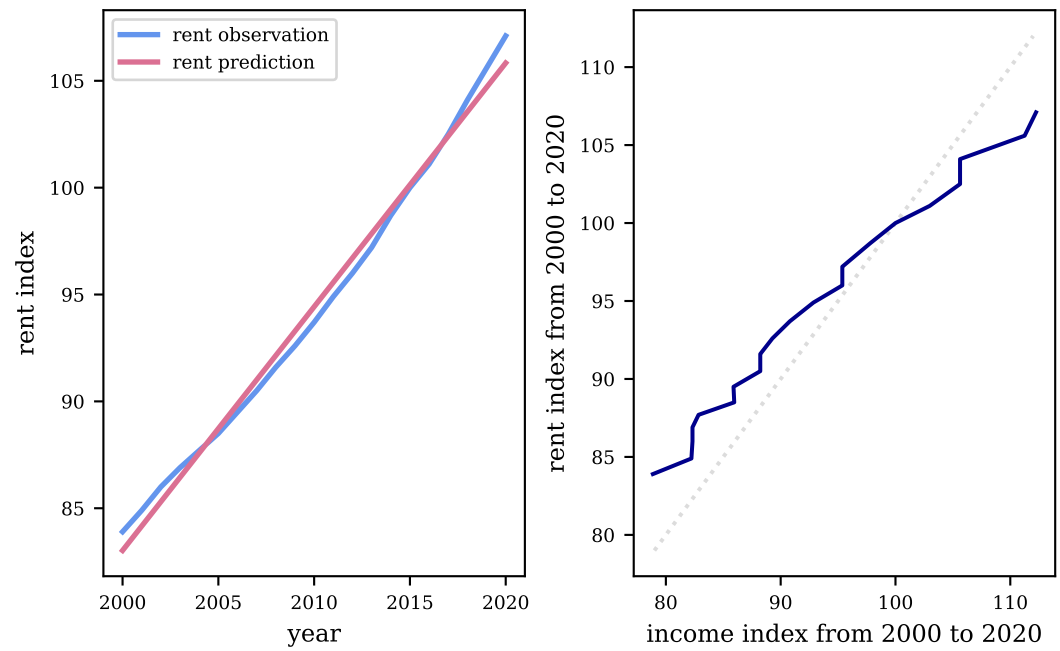

Figure 2: Left: Rent index observation and rent index prediction using time as explanatory variable. Right: Pairplot for income index and rent index.

is 1.14 (MSE: 0.381, Fig. 2, left). The income index regression coefficient is 1.58% (MSE: 3.58). I.e., each year the rent (income) increases by 1.4% (1.58%) of rent (income) in 2015.

Figure 3 shows the regression coefficients for each federal state separately, using time as a explanatory variable. One coefficient at the left (Sachsen) and one on the right (Bremen) look like outliers. In order to test if they deviate significantly from the other coefficients, I assumed all other coefficients to be gaussian distributed and computed their maximum likelihood distribution (see Fig. 3). Using a two-sided test with the maximum likelihood distribution as H_0 and $\alpha = 0.05$, both the coefficient of Bremen (P=0.034) and the coefficient of Sachsen (P=0.0046) were significant. However, when applying the Bonferroni correction to α, only the coefficient of Sachsen remained significant.

Discussion

While it is possible that construction cost, available living space and rent development correlate, the best explanatory variable for rent development has been time (Fig. 2, left). Especially the living space per population feature - having a very small coefficient and changing from positive to negative over the years (Fig. 1, right) - doesn't seem to be a suitable predictor for the available rent data.
In connection with this, it is interesting to see that while according to the owners' association Haus und Grund demand on the housing market still exceeds supply, the living space per population index has continually increased over the last years (see Fig. 1) [8]. However, housing shortage and high rent seem to be most of a problem in major cities [9]. As a result, while some areas might experience positive effects of newly created living space on rent, this trend might only be visible in local data, but not for data describing rent in Germany as a whole. The difficulty of describing rent development in Germany as a whole is aggravated by finding significant differences in rent development between federal states. In order to verify these differences it would be helpful to obtain the missing data values for Hamburg and Schleswig-Holstein.

Overall, in order to be able to use more features and find reliable correlations between explanatory variables and rent it will be necessary to collect a lot more data and possibly estimate the development separately for different parts of Germany and rural or urban areas. In any case, the income index increasing more strongly than the rent index indicates a positive development of rent affordability.

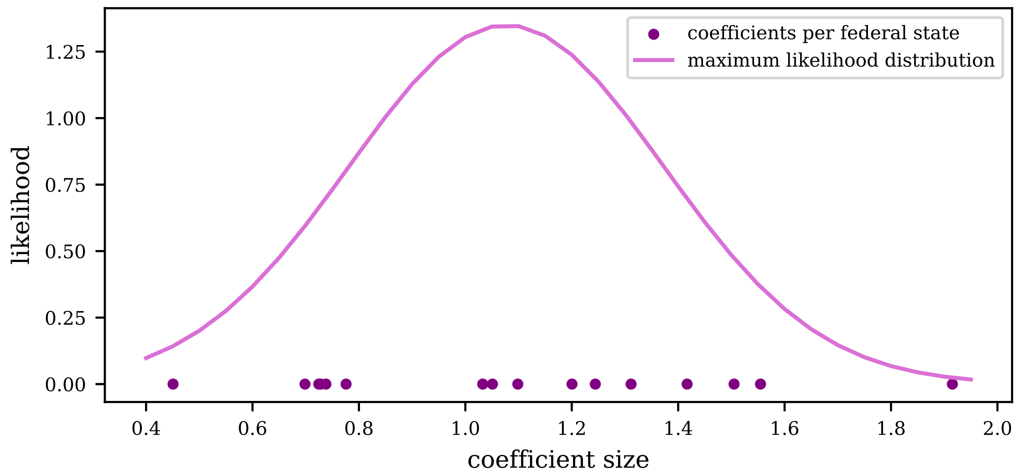

Figure 3: Coefficients per federal state and maximum likelihood distribution for all coefficients but the smallest and largest one.

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