The effect of mobility access on house prices in urban, suburban and rural areas within the Netherlands.

Abstract

The gap between poor and rich areas is increasing. One way to deal with this issue, is improving (the) mobility access, such as public transport. This thesis tries to provide more insight in this problem and provides an answer to the following question: "*"Is there a difference in the effect of mobility access on house prices between urban, suburban and rural areas within the Netherlands?* The research question is answered by doing a quantitative analysis using secondary data. This thesis suggests that there is no relation between the access to mobility and house prices. Therefore, there is no difference in the effect of mobility access on house prices between urban, suburban and rural areas within the Netherlands.

Assignment 7: Final version of bachelor's thesis
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Introduction

"Cities are 'our greatest invention' and make us 'richer, smarter, greener, healthier, and happier' (Glaeser, 2013). Whereas cities are the main centre of development and economic activity, the opposite can be said about places in rural areas. These so-called 'places that don't matter' are places with poor development prospects and an increasing belief that these places have 'no future' (Rodrigues-Pose, 2018). This belief widens the gap between the rich and poor areas even more since it is less likely for people and firms to locate themselves in a declining area.

This socio-territorial inequality is studied in more detail by Jorge (2018). He researched the influence of mobility access in the Buenos Aires Metropolitan Region. His study suggests that the lack of mobility access increases socio-territorial inequality. Jorge (2018) states that: "mobility can also be regarded as an intermediary for different activities within the city, and thus it could be referred to as a need and as a right since it determines the access to goods, services and activities that are essential for the production and reproduction of social life. The absence of such an intermediary function would restrict households' possibilities to the proximity of surrounding space, constraining the access to resources available at a metropolitan scale".

Another example of a study on mobility access or accessibility is the research of El-Geneidy et al (2015). They divided Toronto, Canada into ten socio-economic decile and then compared the average accessibility to jobs of each decile. The lowest decile, which is also the most vulnerable one, had a relative high level of accessibility compared to the rest of the region. But the other two lowest deciles, had an accessibility level that was below the average. According to El-Geneidy et al (2015), these deciles are in need of attention in terms of transport interventions. Looking at the study of Jorge (2018) as well, there seems to be a clear pattern regarding the access to mobility and the possibilities for households or individuals.

Research problem

The lack of mobility widens the gap between the poor and the rich areas, but it might also work the other way around. Improvements in mobility access, such as public transport, could narrow the gap between urban and rural areas. An indicator of this gap could be house prices. If the house prices of a certain area rise, then you could say that that area becomes more popular to live in. This thesis will try to provide an answer to this issue and will create new insights for policy makers regarding mobility infrastructure planning.

For this thesis, the following main question is formulated:
"Is there a difference in the effect of mobility access on house prices between urban, suburban and rural areas within the Netherlands?"

The following sub-questions are formulated to help answer the main research question:

- What is the effect of mobility on house prices within the Netherlands?
- What is the effect of mobility on house prices in urban areas within the Netherlands?
- What is the effect of mobility on house prices in rural areas within the Netherlands?
- What is the effect of mobility on house prices in suburban areas within the Netherlands?

The first chapter, the Theoretical framework, will give an overview of the existing literature regarding this topic. In the Methodology chapter, the theories from the Theoretic framework will be operationalized and explanations will be given about the data collection and analysis procedure. The data analysis will then be conducted in the Results chapter. This chapter will provide the answers to the four sub-questions. The answers of the sub-questions combined will form a conclusion to the main question. This can be read in the Conclusion chapter, together with the implications and limitations of this research.

Theoretical framework

Increase in Land Value:

Accessibility is very important for regions or provinces. In 2017, all the provinces in the Netherlands combined, invested around 2.3 billion euros in traffic and transport (OVPro, 2017). This is 40% of the total budget of these provinces. Most of 2.3 billion euros are invested in roads (46%) and public transport (42%). The investments in accessibility is beneficial for both people and firms. This can be seen within the European Union, where the Regional Policy/Cohesion Policy is the EU's main investment tool, containing almost a third of the total budget of the EU (2019a). This money is, among other things, invested in infrastructure in regions that lack behind. In addition to this, the EU is working together with countries, regions and partners to promote urban-rural linkages (2019b). According to the EU: "The benefits of stronger urban-rural cooperation include more efficient land use and planning, better provision of services (e.g. public transport, health) and better management of natural resources" (2019b).

An indicator for the effect of transport is the land value. According to Du and Mulley (2006), classical urban land economics theories suggests that one important factor of land value is transport costs. Accessibility to services employment and amenities will be significantly improved by the presence of transport infrastructure such as highways or rail systems. Du and Mulley (2006) provides the following statement: "With increasing distances to the Central Business District (CBD), where employment and amenities concentrate, the land value increases as a result of the decreasing transport costs". Moeller et al (2013) examined this in more detail. They state that the land value will rise the most in very central and very peripheral areas. This is in the very CBD probably the case due to agglomeration economies and due to commuting reduction in the very peripheral areas.

Daams et al (2016) research about the effect of natural space on property prices has some similarities with this research. Their research suggests that the on average, buyers pay a 16% premium on properties within .5km of attractive natural space and this premium decreases to 1.6% for properties 6 to 7 km away (2016). While natural space is something different than the mobility access, results with a similar structure can be expected.

Supply or demand

The relationship between transport infrastructure and land value is two sided. Namely, a demand driven relationship and a supply driven relationship. The supply driven relationship is that the supply of new transport infrastructure will lead to higher land value around the facilitated infrastructure. The demand driven relation means that an increase in land value leads to the supply of new transport infrastructure. In an article of Levinson (2008), both processes are being evaluated.

Levinson (2018) uses land development instead of land value. Levinson (2018): "High density land development encourages the investment in rail infrastructure and that rail infrastructure increases densities. However, the story is more complicated because rail, as a transportation network, enables people to move from here to there. As such, it increases densities for certain activities (e.g. Jobs) in some places (e.g. downtown), and for other activities (e.g. houses) in different places (e.g. the suburbs). By increasing densities for jobs in downtown, it is simultaneously decreasing housing densities in those same places both by making housing in the core more expensive (it is competing with commercial activities for scarce land) and making housing outside the core have greater accessibility.

The accessibility of train stations

While the presence of train station increases the access to mobility, one important factor that needs to be considered is the access to those train stations, or just public transport hubs in general. According to Rietveld (2000b), the accessibility of the train stations is one of the more important factors whether people choose to travel with the train or not. The accessibility of the train station is split up into two compartments in the study of Rietveld (2000b), namely from home to the train station, and from the train station to the activity. What is particularly interesting for this thesis, is the fact that in a Dutch context, the bicycle is the dominant choice of transport from the home to the train station. The other dominant choice is walking.

The choice for the bicycle is no surprise if you keep another research of Rietveld (2000a) in mind. In that research, he states that 85% of the total population in the Netherlands owns a bicycle, and 50% of the bicycle owners uses it on a regularly basis. In addition to this, the road network, facilities are rather good in the Netherlands compared to other countries.

In these other countries, the accessibility of train stations might be worse than for the Netherlands, since they don't have the same benefits of the bicycle. Two kilometers is more of an obstruction if you need to walk compared with cycling. This suggest that the distance to the closest train station is of less importance in the Netherlands than in other countries relatively speaking.

Conceptual model

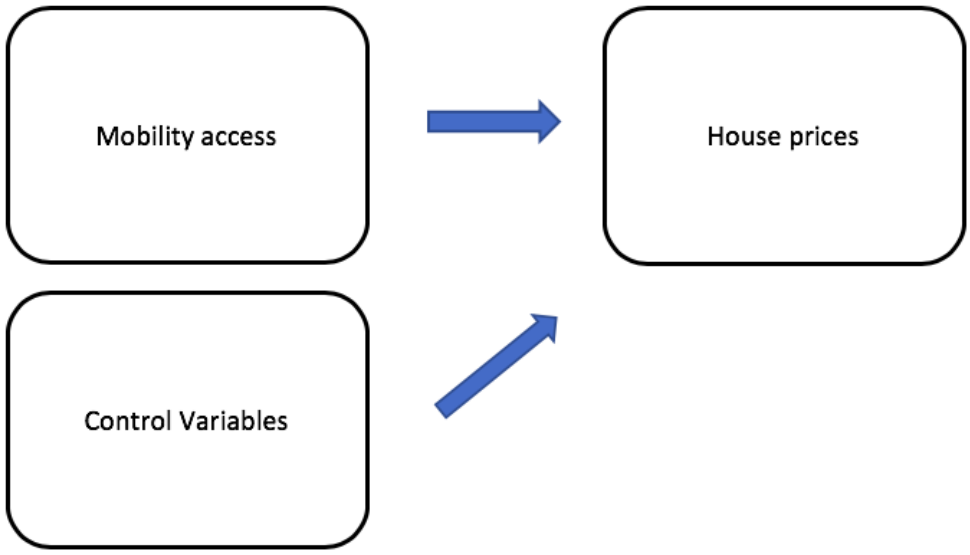

Figure 1: Conceptual model

The conceptual model as can be seen in figure 1 and consists of three components that influence each other. These components are collected and provide proof for the possible relationship between each other.

The first component of the model is mobility access. A change in mobility access has an effect on the house price and not the other way around. It could be argued that house prices have an effect on the mobility access, namely the demand driven relationship, but the change of one single house price won't have a significant influence on the mobility access. That is why, in this conceptual model (figure 1), the relation is one-sided. The independent variables that are being classified as 'mobility access' are: 'Distance to closest train station' and 'Distance to ramp main road' (appendix 1). For both variables, the value indicates the average distance (in kilometers) to the facility in each municipality.

The second component of the model are the control variables. These control variables are independent variables that have an effect on the dependent variable. This effect does not apply the other way around, hence why the arrow points in one direction only. Control variables are used to make a statistical regression have a higher validity and trustworthiness.

In this thesis, a total of fourteen control variables are being used. The full list of control variables can be seen in appendix 1. The first eleven control variables follow the same structure. They are all distances to a certain facility/amenity and follow the same interpretation of the value as the independent variables. Namely that the value indicates the average distance (in kilometers) to the facility in each municipality.

Another control variable is the average income of the municipality. This value is in euros. The average income of the municipality is expected to have an influence on the average house prices in the municipality, since income is a good representation of what people are willing to pay for a house. Someone with a high income will generally spend more money on a house than someone with a low income.

The next control variable is the average floorspace of the houses of the municipality in square meters. A house with a much floorspace will generally lead to a higher house price than a house with low square meters of floorspace. The average floorspace of a municipality is thus expected to have an influence on the average house price per municipality.

The last control variable is the percentage of the houses that are owner-occupied in the municipality. There is a difference in house price between houses that are owner-occupied and houses that are rented. The percentage of the houses that are owner-occupied in the municipality is thus expected to have an influence on the average house price of the municipality.

The third component of the model is house prices. The dependent variable that associated with this is: ‘Average house price per municipality’.

Hypotheses

The hypotheses for this research is as follows. Access to mobility has a positive effect on the house prices within the Netherlands. The better the mobility access of a house will be, the higher the increase in house price. It is expected that this will vary between urban, suburban and rural areas. Rural areas, in general, will have a higher dependency on commuting than urban areas. The impact of access to mobility will therefore lead to a higher increase in house price as compared to the increase of house price in urban or suburban areas respectively.

Methodology

A quantitative research, with secondary data, is conducted to answer the research questions.

The dataset that is being used is from the 'Centraal Bureau voor de Statistiek'. This entity is responsible for collecting and publishing statistical data about the Netherlands. The database is free to use and has all sorts of data available. For this research, the CBS provides statistical data on both the 'mobility access' part and the 'house price' part. The scale for 'house prices' is even given for each neighborhood within the Netherlands. The scale of this research will be on municipality level however, since the data for the 'mobility access' part is only available for that scalar level.

The urbanization degree is being used to make the distinction between the three types of classification (urban, suburban and rural). This is based on the area address density per square kilometer of every municipality. Municipalities with an area address density per square kilometer of <2500 to 1500 addresses are classified as urban areas. Suburban areas are municipalities with an area address density per square kilometer of 1499 to 1000 addresses. Lastly, rural areas are municipalities with an area address density per square kilometer of 999 till 0 addresses.

Data analysis:

The variables, as can be seen in appendix 1, is analyzed using the multiple linear regression. A multiple linear regression is a statistical test that is used when you want to explain an outcome (dependent variable) with multiple explaining variables (independent). By performing the test in SPSS, the result in this case is the change in average house price per municipality if the distance to the closest train station or the distance to ramp main road increases with 1 kilometer The formula and an explanation of every component can be seen in appendix 2.

A total of 4 multiple linear regressions are conducted. The first regression shows the effect of mobility on house prices within the Netherlands without looking at a certain type of area. The second multiple linear regression shows the effect of mobility on house prices in urban areas, the third regression will show the effect of mobility on house prices in suburban areas and the fourth regression will show the effect of mobility on house prices in rural areas. These will be the answers to the sub-questions respectively. Together, the answers to the sub-questions will form the conclusion to the main research question.

Besides SPSS, another program is being used in this thesis, namely ArcGIS. Visual representations of the dataset in the form of maps can be provided using this program. In this thesis, it will give an overview of the municipalities of the Netherlands and their values of the most important variables.

Ethical considerations:

Ethical considerations occur during the data collection most of the time. For this research, only secondary data is being used. This data is already collected by other organizations or researchers so most of the ethical considerations that were needed to be done are already taken care of by others. This can create some difficulties. There is less information available on how the researcher have collected their data or dealt with ethical considerations themselves. A critical view on the secondary data was necessary to make sure that this research is valid, trustworthy and ethical.

Results

Descriptive statistics

	N	*Minimum*	*Maximum*	*Mean*	*Std. Deviation*
Average house price per municipality	344	119,000	325,000	215,921.51	43,393.469
Distance to closest train station in kilometer	344	1.0	16.4	5.596	3.8604
Distance to ramp main road in kilometer	344	.5	2.7	1.516	.4592
The municipality is urban	344	0	1	.24	.430
The municipality is suburban	344	0	1	.21	405
The municipality is rural	344	0	1	.55	.498

Table 1: Descriptive statistics

In table 1, a summary of the descriptive statistics can be found. This table consists of the descriptive statistics of the dependent variable, the independent variables and the selection variables. The descriptive statistics for the control variables are excluded in this table for visual reasons but are included in the descriptive statistics table that can be found in the appendix (appendix 3a).

The dependent variable is the average house price per municipality. The mean of the average house price per municipality is 215,921.51 Euro's, with a standard deviation of 43,492,469. While the mean is not either high or low, the standard deviation does show a high value.

The standard deviation tells something about the concentration of the data around the mean of the dataset. A low standard deviation means that most of the values are very close to the average, a high standard deviation means that the values are spread out. In this case, the standard deviation is relatively high. This means that the average house prices have a high variance across the dataset, which is expected.

For the independent variables, distance to closest train station and distance to ramp main road, the only descriptive statistic which is standing out is the standard deviation of the distance to the closest train station. This is also relatively high, but this is not good or bad: it just shows that there is a high variance among the cases.

The selection variables work a bit different. This is not an absolute value, but rather a percentage. This is because the variables are dummy variables, meaning that there are only 2 options. The mean for these variables shows the percentage that is urban, suburban or rural. In the case for urban for example, 24% of the municipality are classified as urban areas.

What is not being showed in the descriptive statistics is the frequency of the classifications. These tables can be found in appendix 3b. The number of municipalities classified as 'urban areas' is 84. The number of municipalities classified as 'suburban areas' is 71. Lastly, the number of municipalities classified as 'rural is 189. The total number of municipalities is 344.

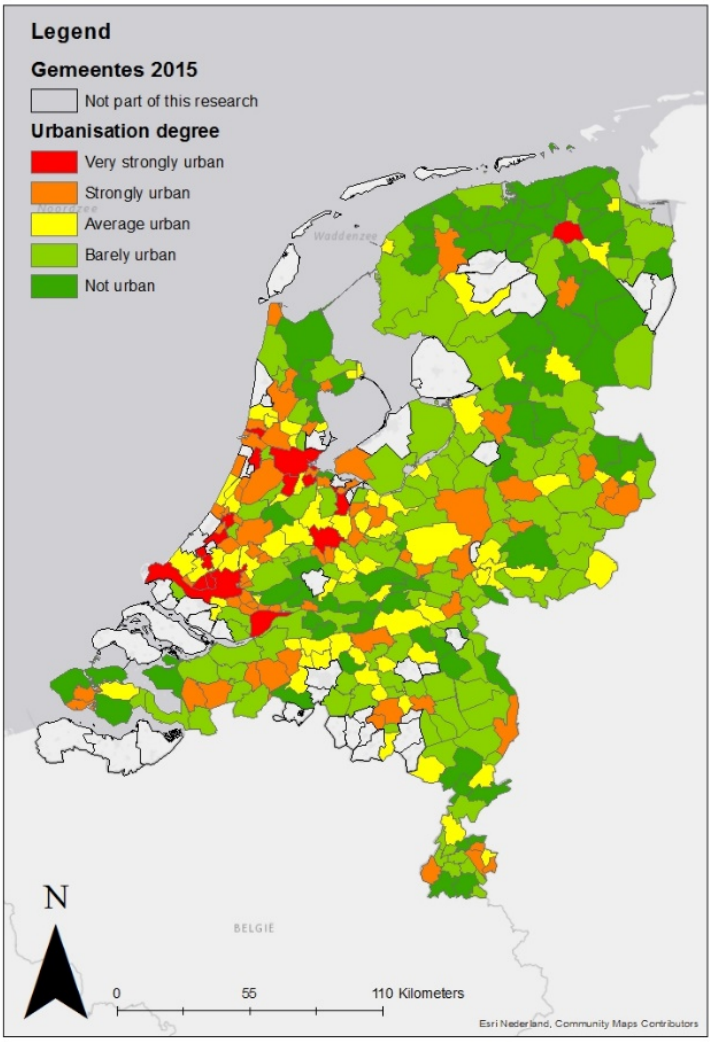

Figure 2: Visualisation of the urbanisation degree

Figure 2 shows the urbanization degree where the 3 classifications are based on. The classification of urban areas consists of both 'very strongly urban' (red) and 'strongly urban' (orange) municipalities. The classification of suburban areas is the 'average urban' (yellow) municipalities. The classification of rural areas consists of both 'barely urban' (light green) and 'not urban' (dark green).

More importantly, the white municipalities are municipalities that are not part of this research. First of all, the Wadden islands (Texel, Vlieland, Terschelling, Ameland and Schiermonnikoog) are removed. These islands do not share the same characteristics as all the other municipalities and are therefore not in the scope of this research. Furthermore, the other municipalities are removed since they were outliers in the dataset in either the variable; “average house price per municipality”, “distance to closest train station” or “distance to ramp main road”.

These outliers are removed by using boxplots for every variable respectively. An example of a boxplot can be found in appendix 7. The boxplot is a visualization of all the cases of a certain variable. It shows which cases can be considered as extreme values. These cases or municipalities are not representative for the Netherlands and are thus removed. A total of 50 cases have been removed.

Quantitative analysis:

Model summary:

	R	*R Square*	*Adjusted R Square*	*Std. Error of the Estimate*
Without selection variable	.907	.823	.815	18,728.730
Urban	.946	.895	.869	14,863.831
Suburban	.904	.818	.764	20,761.381
Rural	.915	.838	.823	18,128.884

Table 2: Model summary

Table 2 is the first table of the regression, namely the model summary. The first component R shows the correlation between the real results and the predicted result based on the cases. A high correlation is preferred since the higher the correlation, the better the prediction is.

The next component is the R square. This shows the percentage of the explained variance. The Adjusted R square keeps the number of variables in mind that are being used to explain the percentage of the variance.

The last component of this model is the Standard error of the Estimate. This value shows the distance of every point towards the regression line. The lower this value, the better.

What is the effect of mobility on house prices within the Netherlands?
The correlation for the model without a selection variable is .907 which is high. 82.3% of the variance is explained by this model, and the Standard error of the Estimates in this model is 18,728.730 which is high due to a high level of variance among the cases.

What is the effect of mobility on the house prices in urban areas within the Netherlands?
In this regression, a selection variable is added, in this case the selection variable: ‘The municipality is urban’. This means that only cases or municipalities that are being classified as ‘urban’, are included in this regression. The other cases are left out.
Table 2 shows a high correlation (.946) between the real results and the predicted results based on the cases that are classified as urban. 89.5% of the variance is explained by this model, which is high. The Standard error of the Estimates is high as well, namely 14,863.831. This is because the high level of variance between the cases.

What is the effect of mobility on the house prices in suburban areas within the Netherlands?
The selection variable for this regression is 'the municipality is suburban'. Only cases or municipalities that are suburban are included in this regression.

The table (2) shows that there is a high correlation (.904) between the real results and the predicted results based on the cases. 81.8% of the variance is explained by this model, which is the lowest from the 4 models, but can still be seen as high. The Standard error of Estimates is higher than the previous models (20,761.381). This suggests that there is a higher variance in suburban areas than in the other classifications.

What is the effect of mobility on the house prices in rural areas within the Netherlands?
The selection variable for this regression is 'the municipality is rural'. Only cases or municipalities that are rural are included in this regression.

The regression for the rural classification is in line with the other two classifications. The model summary (table 2) shows, once again, a high correlation (.915) between the real results and the predicted results based on the cases. 83.8% of the variance is explained by this model, which is high. The Standard error of Estimates (18,128.884) is high as well due to the high variance among the cases.

ANOVA and Coefficient table:

	Without the selection variable		*Urban*		*Suburban*		*Rural*	
	B	Sig.	B	Sig.	B	Sig.	B	Sig.
Regression		.000*		.000		.000		.000
Constant	-184,896.461	.000	-157,982.299	.000	-76,335.376	.087	-252,695.384	.000
Distance to closest train station	134.373	.684	1229.133	.194	25.984	.973	-266.30	.523
Distance to ramp main road	2635.217	.256	-2170.469	.653	-7704.091	.291	5294.621	.067

*P <.05

Table 3: ANOVA and Coefficients table

First of all, because of visibility reasons, the control variables are removed from table 3 They are included in the regressions but are simply not visible since they are not of importance for the explanation of this model. The full tables of every regression can be found in appendix 8.

Table 3 shows a summary of the ANOVA and Coefficient table containing the most important results. There are two values in table 3, the unstandardized B and the significance level.

The unstandardized B, or the regression coefficient, is shown as 'B'. Using the unstandardized B for the independent variable 'Distance to closest main train station' without a selection variable as an example, the interpretation of the unstandardized B is as follows: The unstandardized B for the independent variable is 134.373. This means that for every kilometer to the closest train station in a municipality, the average house price of that municipality rises with 134.373 euro. Seen that the constant is -184,896.461 (see, which is the average house price if all the values of the explaining variables are 0, the effect of the distance to the closest train station is minimal).

The second value in table 3 is the significance level (sig.). Before looking at this value, a null hypothesis needs to be formulated. In the case of the whole regression without a selection variable, the null hypothesis is formulated as: 'In the population there is no linear relation between the dependent variable and the independent variables. If the significance level is <.05 than the null hypothesis needs to be rejected. In the case of the example, this level is .000. This means that there is a relationship between the dependent variable and the independent variables, and that the null hypothesis can be rejected. If a relation between two variables fails to be significant (high significance level), that does not mean that there is no relation between the two variables. It means that the data provide little or no evidence that the null hypothesis is false.

What is the effect of mobility on house prices within the Netherlands?
The significance level of the whole regression without a selection variable is .000 (table 3). This means that there is a relationship between the dependent variable and the independent variables. The next step is formulating a null hypothesis for both the independent variables which is as follows: "There is no relation between the dependent variable 'average house price per municipality' and the independent variable 'distance to closest train station'". The same null hypothesis can be formulated for the independent variable 'distance to ramp main road'. Both of the independent variables fail to be significant, namely .684 and .256 respectively. The null hypothesis cannot be rejected and there is thus no significant relationship between the dependent variable and both the independent variables.

The unstandardized B shows in both variables, a positive value. Namely 134.373 for the independent variable 'Distance to closest train station' and 2635.217 for the independent variable 'Distance to ramp main road'. This would suggest that the average house price would increase per kilometer that the facilities are away, especially for the distance to the closest ramp main road. A reason for this could be that people generally won't want to live next to a large road with a high amount of traffic.

What is the effect of mobility on the house prices in urban areas within the Netherlands?
As can be seen in table 3, the regression itself is significant (.000). As a result, the null hypothesis concerning the whole regression does not have to be rejected and the values of the independent variables can be interpreted. The independent variable 'distance to closest train station' has a significance level of .194. For the independent variable 'distance to ramp main road' this level is .653. Both of the independent variables fail to be significant. Thus, there is no significant relationship between the 'average house price per municipality' and the 'distance to closest train station' or 'distance to ramp main road' in urban areas within the Netherlands.

The unstandardized B shows a positive value (1229.133) for the variable 'distance to closest train station', but a negative value (-2170.469) for the variable 'distance to ramp main road'. In case for the distance to closest train station' this suggest that the house prices are lower, the closer you are to the train station in urban areas. A reason for this could be that in urban areas, the train station is mainly located in dense areas with smaller houses, and thus lower house prices, compared to other neighborhoods. It can also be the case that people in urban areas simply don't want to live next to a train station. The negative value of the variable 'distance to ramp main road' suggests that people are willing to pay more for their house when it is located closely to a ramp main road. Decreasing commuting time could be a reason for this.

What is the effect of mobility on the house prices in suburban areas within the Netherlands?
The null hypothesis about the relationship between the dependent variable and the explaining individual variables needs to be rejected, since the significance level is .000 (table 3). The significance levels of both independent variables suggest that there is no significant relation between the dependent variable 'average house price per municipality' and both of the independent variables 'distance to closest train station' and 'distance to ramp main road' in suburban areas within the Netherlands. The significance levels are .973 and .291 respectively.

The unstandardized B's shows the same pattern in suburban areas as in urban areas. Namely a positive value for the independent variable 'Distance to the closest train station and a negative value for the independent variable 'Distance to ramp main road'. The unstandardized B is close to 0 for the independent variable 'Distance to closest train station'. This suggests that the variable has only a really small influence on the average house price of the municipality. This explains the high significance level of .973. The negative value of -7704.091 for the variable 'Distance to ramp main road' is higher in suburban areas than in urban areas (-2170.469). This suggests that people are willing to pay more for houses that are close to a ramp main road in suburban areas than in urban areas.

What is the effect of mobility on the house prices in rural areas within the Netherlands?
The significance level of the whole regression shows a significance level of .000 (table 3). This means that the null hypothesis has to be rejected and that there is a relationship between the dependent variable and the explaining variables. In addition to the other type of classifications, the coefficient table (table 3) shows that there is no significant relationship between the dependent variable 'average house price per municipality' and both of the independent variables 'distance to closest train station' (.523) and 'distance to ramp main road' (.067). However, it is worth mentioning that the significance level of <.05 is not a general rule. A significance level of .051 would not immediately mean that there is no relationship between the variables. In the case of the variable 'distance to ramp main road', the significance level of .067 suggests that the distance to the closest ramp main road in a municipality do have an influence on the average house price in a municipality in rural areas.

The unstandardized B's for the rural areas are not in line with the other 2 classifications (urban and suburban). Instead of a positive correlation between average house price and the distance to the closest train station, there is a negative correlation (-266.30) in rural areas. Although it has a small influence, the result suggests that houses that are located close to a train station have a higher price. The unstandardized B shows a positive correlation (5294.21) between the average house price and the distance to ramp main road. This suggests that the house prices are higher, the further away the house is located from the closest ramp main road.

Conclusion

Based on the result, the conclusion for following main research question: *""Is there a difference in the effect of mobility access on house prices between urban, suburban and rural areas within the Netherlands?"* is as follows: There is no difference in the effect of mobility access on house prices between urban, suburban and rural areas within the Netherlands. The quantitative analysis shows that in all of the above three types of classification, or even without a classification, the distance to the closest train station and/or the distance to the main ramp road does not have an effect on the house prices. The access to mobility is thus of less importance to people within the Netherlands. This insight could be helpful for the planning of mobility infrastructure.

This conclusion means that the hypothesis needs to be rejected. Looking at most of the literature, it was expected that the better the mobility access of a house would be, the higher its price. This is shown not to be true in the case of the Netherlands. This can be explained by two possible reasons: The first one is that the Netherlands has a unique situation with its bicycles. The bicycle makes it easier for people to commute to a train station compared to walking. This can lead to the fact that the distance to the closest train station is of less importance for people within the Netherlands.

The second explanation has a relation with the limitations of this research. One limitation of this research are the independent variables that cover the mobility access component. It could be the case that the variables 'distance to closest train station' and 'distance to ramp main road' are not the proper indicators of the access to mobility. In addition, a lower real distance ('as the crow flies') to a certain mobility facilitator does not directly mean that it is better accessible. But still, these two variables were the most viable options for this research since mobility access is hard to measure, especially on such scalar level. Another limitation of this research is that there are simply more important factors that determine the house price than the access to mobility; for example, floorspace. This could be a reason why the variables failed to be significant. In addition to this, the p-value (or significance level) that is necessary for a significant relationship is arbitrary. The choice for a necessary p-value of <.05 in this thesis can thus be discussed, but a change in this necessary value would not have led to a different conclusion.

For further research, a more specified study can be conducted regarding this topic. Focusing on a single municipality could lead to different but more precise results. This could be more beneficial to the chosen municipality as compared to this study, which had a broader aim.

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Appendix 1: Overview of cases and variables

Cases

Cases	**N**
Municipalities of the Netherlands in 2015	344

Table 4: Cases

Variables

Dependent Variable	**Unit**	**Explanation**	**Source**
Average house price	Euro's		CBS Statline
Independent variable:			
Distance to closest train station	Kilometers		CBS Statline
Distance to ramp main road	Kilometers		CBS Statline
Selection variable:			
Is the municipality urban	1: urban 0: not urban	Dummy variable	Derived from the area addresses density per square kilometer
Is the municipality suburban	1: suburban 0: not suburban	Dummy variable	Derived from the area addresses density per square kilometer
Is the municipality rural	1: rural 0: not rural	Dummy variable	Derived from the area addresses density per square kilometer
Control variables:			
Distance to General Practice	Kilometers		CBS Statline
Distance to Hospital	Kilometers		CBS Statline
Distance to Day-care	Kilometers		CBS Statline
Distance to Elementary School	Kilometers		CBS Statline
Distance to 'VMBO'-school	Kilometers		CBS Statline
Distance to HAVO/VWO school	Kilometers		CBS Statline
Distance to big supermarket	Kilometers		CBS Statline
Distance to Restaurant	Kilometers		CBS Statline
Distance to Library	Kilometers		CBS Statline
Distance to Cinema	Kilometers		CBS Statline
Distance to Swimming Pool	Kilometers		CBS Statline
Average income of the municipality	Euro		CBS Statline

Average floorspace of the houses of the municipality	Square meters		CBS Statline
Percentage of the houses that are owner-occupied in the municipality	Percentage		CBS Statline

Table 5: Variables

Appendix 2: Data analysis scheme

The formula for the multiple linear regression is as follows:
"Y = B0 + B1X1 + B2X2 + Control Variables + ε".

Component	Explanation
Y	The dependent variable. In this case, the 'average house price per municipality' (table 2).
X1, X2, …	The independent variables and control variables. The list of variables can be seen in table 2.
B0	Intercept. Prediction of Y when all X's are 0. In this case, it shows the average base value of the house per municipality. The average house price is a combination of factors, and the intercept shows the base house price without adding the effect of each independent variable.
B1, B2, …	Regression Coefficients. The regression coefficient tells you how much of Y will rise when the X's rise. In this case, it shows change in house price when for example the distance to the closest train station will increase with 1 kilometer.
ε	Error term. The error term represents the margin of error within a statistical model. It provides an explanation for the difference between the results of the model and actual observed results.

Table 6: Data analysis scheme

Appendix 3: Descriptive Statistics and frequencies classifications

3a: descriptive statistics

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation	Variance
Average house price per municipality	344	119000	325000	215921,51	43493,469	1891681868,262
Distance to closest train station in kilometer	344	1,0	16,4	5,596	3,8604	14,903
Distance to ramp main road in kilometer	344	,5	2,7	1,516	,4592	,211
The municipality is urban	344	0	1	,24	,430	,185
The municipality is sub-urban	344	0	1	,21	,405	,164
The municipality is rural	344	0	1	,55	,498	,248
Distance to general practice in kilometer	344	,5	2,5	1,128	,3810	,145
Distance to hospital in kilometer	344	1,5	28,4	9,187	5,0677	25,682
Distance to daycare in kilometer	344	,4	4,0	1,056	,5570	,310
Distance to elementary school in kilometer	344	,5	1,3	,740	,1606	,026
Distance to VMBO-school in kilometer	344	,9	14,0	3,485	2,1328	4,549

Distance to HAVO/VWO-school in kilometer	344	1,1	15,3	4,338	2,7765	7,709
Distance to big supermarket in kilometer	344	,5	2,6	1,057	,3786	,143
Distance to restaurant in kilometer	344	,3	3,5	,961	,3645	,133
Distance to library in kilometer	344	,7	14,5	2,000	1,2153	1,477
Distance to cinema in kilometer	344	1,3	26,8	8,222	4,7574	22,633
Distance to swimming pool in kilometer	344	1,1	18,3	3,995	2,5477	6,491
Average income per household excluding students	344	31600	53800	41193,90	4112,371	16911595,278
Average floor space per municipality	344	75	253	132,31	22,687	514,706
Percentage of the municipality that is owner-occupied houses	344	29,41	78,10	63,7203	8,44323	71,288
Valid N (listwise)	344					

Table 7: full table Descriptive statistics

3b: frequencies of selection variables

The municipality is urban

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not urban	260	75,6	75,6	75,6
	Urban	84	24,4	24,4	100,0
	Total	344	100,0	100,0	

Table 8: Frequency table - the municipality is urban

The municipality is sub-urban

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not sub-urban	273	79,4	79,4	79,4
	Sub-urban	71	20,6	20,6	100,0
	Total	344	100,0	100,0	

Table 9: Frequency table - the municipality is suburban

The municipality is rural

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not rural	155	45,1	45,1	45,1
	Rural	189	54,9	54,9	100,0
	Total	344	100,0	100,0	

Table 10: Frequency table - the municipality is rural

Appendix 4: Log SPSS

- Variables adding labels etc.
- Adding variable urbanisation degree
- Removing wadden islands since they are not representative for the netherlands
- Removing outliers for: Average house price, distance train, distance main road
    - This is based on boxplots of the variables
- Adding dummy variables: urban, suburban and rural
- Adding three variables that have a certain effect on house prices.
    - Average income of the municipality
    - Average floorspace of the municipality
    - Percentage of the houses that are owner-occupied

Appendix 5: ArcGIS Maps

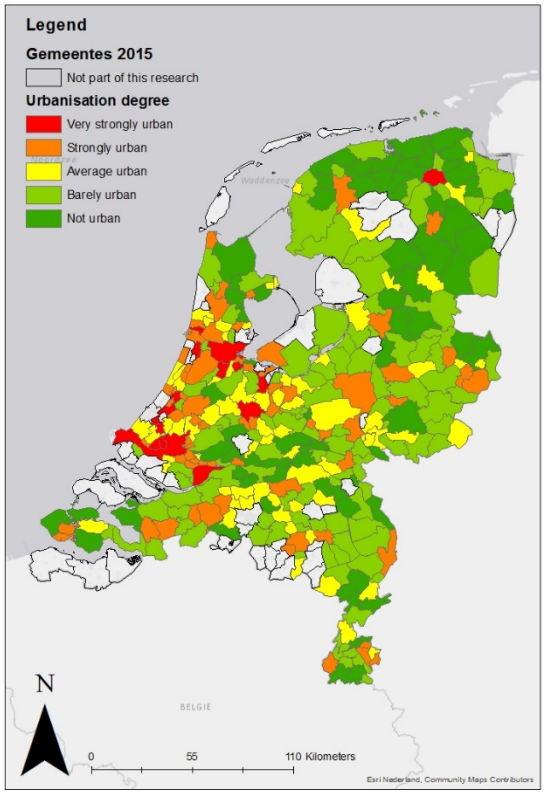

Figure 1: Map - Urbanisation degree

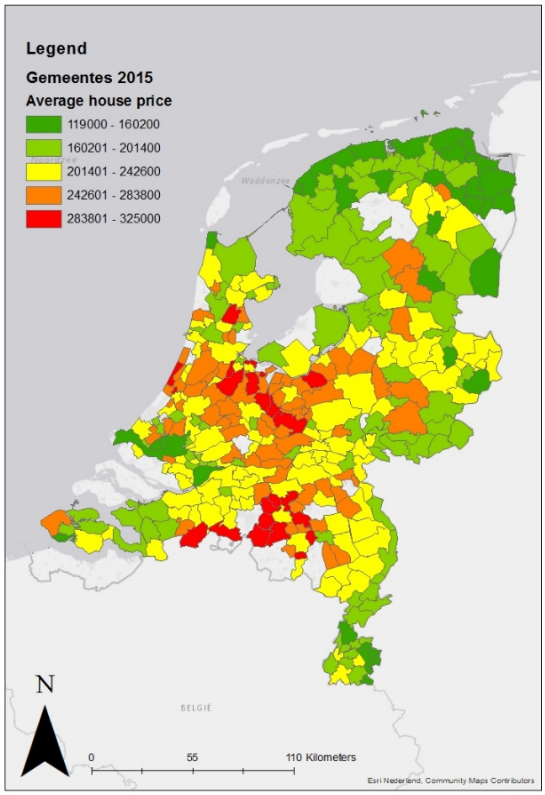

Figure 4: Map - Average house price

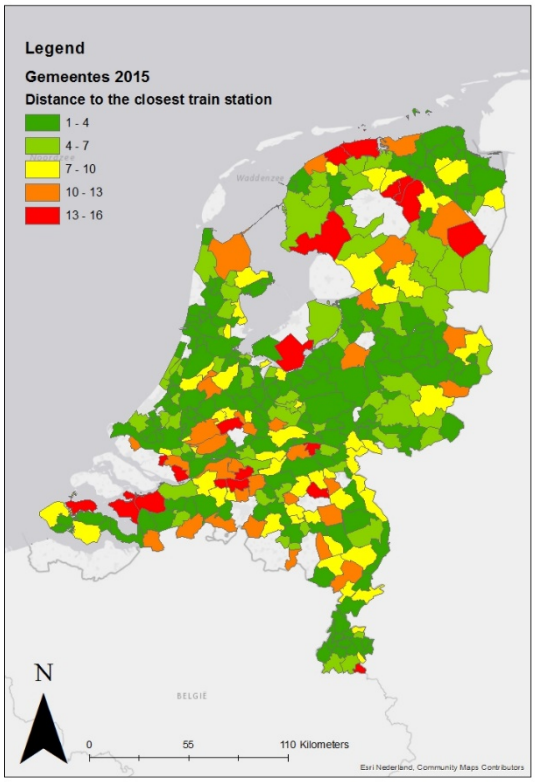

Figure 5: Map - Distance to closest train station

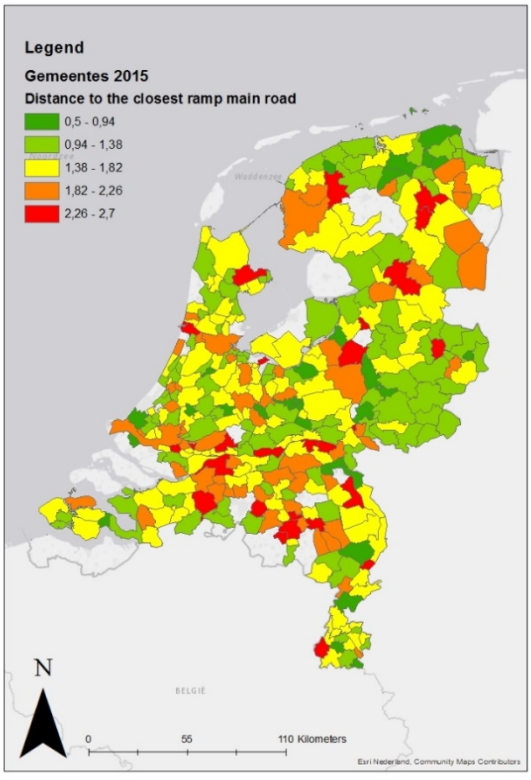

Figure 6: Map - Distance to ramp main road

Appendix 6: Log ArcGIS

ArcMap:

- Adding basemap: lichtgrijze canvas
- Adding map with ArcGIS Online: Gemeenten 2015
- Joining dataset to gemeenten 2015 layer
- Create map: Urbanization degree
- Create map: Average house price
- Create map: distance to closest train station
- Create map: distance to closest ramp main road

Appendix 7: Boxplot

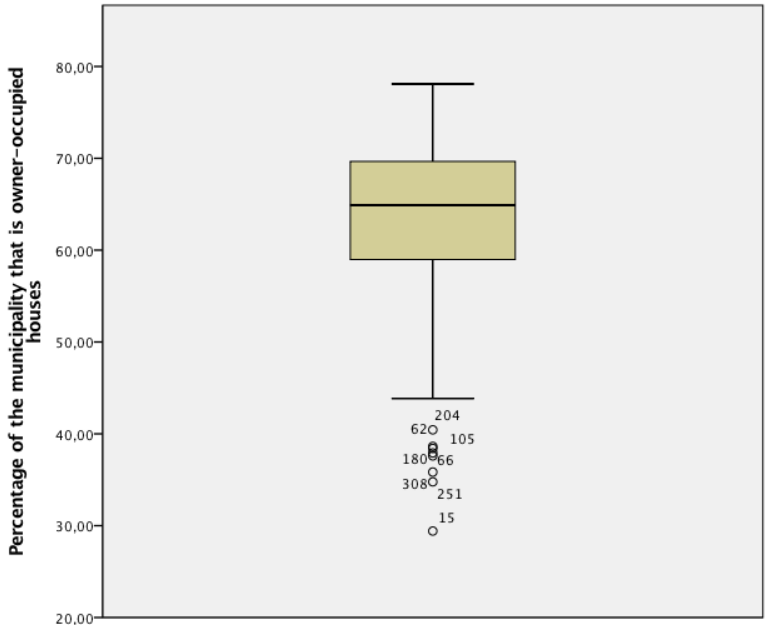

Figure 7: Example of Boxplot

Appendix 8: Regressions

8a: regression for what is the effect of mobility on house price within the Netherlands?

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,907[a]	,823	,815	18728,730

a. Predictors: (Constant), Percentage of the municipality that is owner-occupied houses, Distance to ramp main road in kilometer, Distance to library in kilometer, Distance to swimming pool in kilometer, Average income per household excluding students, Distance to closest train station in kilometer, Distance to restaurant in kilometer, Distance to elementary school in kilometer, Distance to cinema in kilometer, Distance to daycare in kilometer, Average floor space per municipality, Distance to VMBO-school in kilometer, Distance to hospital in kilometer, Distance to general practice in kilometer, Distance to HAVO/VWO-school in kilometer, Distance to big supermarket in kilometer.

Table 11: Regression 1 - Model summary

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	534146621403,497	16	33384163837,719	95,175	,000[b]
	Residual	114700259410,456	327	350765319,298		
	Total	648846880813,953	343			

a. Dependent Variable: Average house price per municipality.

b. Predictors: (Constant), Percentage of the municipality that is owner-occupied houses, Distance to ramp main road in kilometer, Distance to library in kilometer, Distance to swimming pool in kilometer, Average income per household excluding students, Distance to closest train station in kilometer, Distance to restaurant in kilometer, Distance to elementary school in kilometer, Distance to cinema in kilometer, Distance to daycare in kilometer, Average floor space per municipality, Distance to VMBO-school in kilometer, Distance to hospital in kilometer, Distance to general practice in kilometer, Distance to HAVO/VWO-school in kilometer, Distance to big supermarket in kilometer.

Table 12: Regression 1 - ANOVA table

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	-184896,461	13024,676		-14,196	,000
	Distance to closest train station in kilometer	134,373	329,480	,012	,408	,684
	Distance to ramp main road in kilometer	2635,217	2317,546	,028	1,137	,256

	Distance to general practice in kilometer	15254,199	4861,793	,134	3,138	,002
	Distance to hospital in kilometer	908,405	318,256	,106	2,854	,005
	Distance to daycare in kilometer	-5518,160	2447,493	-,071	-2,255	,025
	Distance to elementary school in kilometer	6383,600	9162,269	,024	,697	,486
	Distance to VMBO-school in kilometer	-47,626	832,398	-,002	-,057	,954
	Distance to HAVO/VWO-school in kilometer	44,734	700,969	,003	,064	,949
	Distance to big supermarket in kilometer	-7839,141	5143,972	-,068	-1,524	,128
	Distance to restaurant in kilometer	-11024,027	3775,107	-,092	-2,920	,004
	Distance to library in kilometer	453,780	977,164	,013	,464	,643
	Distance to cinema in kilometer	-348,399	339,174	-,038	-1,027	,305
	Distance to swimming pool in kilometer	-155,801	585,644	-,009	-,266	,790
	Average income per household excluding students	9,992	,300	,945	33,327	,000
	Average floor space per municipality	207,830	63,603	,108	3,268	,001
	Percentage of the municipality that is owner-occupied houses	-722,619	190,575	-,140	-3,792	,000

a. Dependent Variable: Average house price per municipality

Table 13: Regression 1 - Coefficient table

8b: Regression for the effect of mobility on house prices in urban areas within the Netherlands

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate

	The municipality is urban = Urban (Selected)			
1	,946[a]	,895	,869	14863,831

a. Predictors: (Constant), Percentage of the municipality that is owner-occupied houses, Distance to swimming pool, Distance to ramp main road , Distance to closest train station, Distance to VMBO-school, Distance to daycare, Distance to general practice, Distance to cinema, Distance to hospital, Distance to library, Distance to elementary school, Average income per household excluding students, Distance to restaurant, Average floor space per municipality, Distance to HAVO/VWO-school, Distance to big supermarket.

Table 14: Regression 2 - Model summary

ANOVA[a,b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	125539409804,997	16	7846213112,812	35,514	,000[c]
	Residual	14802542575,955	67	220933471,283		
	Total	140341952380,952	83			

a. Dependent Variable: Average house price per municipality.

b. Selecting only cases for which The municipality is urban = Urban.

c. Predictors: (Constant), Percentage of the municipality that is owner-occupied houses, Distance to swimming pool, Distance to ramp main road , Distance to closest train station, Distance to VMBO-school, Distance to daycare, Distance to general practice, Distance to cinema, Distance to hospital, Distance to library, Distance to elementary school, Average income per household excluding students, Distance to restaurant, Average floor space per municipality, Distance to HAVO/VWO-school, Distance to big supermarket.

Table 15: Regression 2 - ANOVA table

Coefficients[a,b]

		Unstandardized Coefficients		Standardized Coefficients		
Model		B	Std. Error	Beta	t	Sig.
1	(Constant)	-157982,299	24093,031		-6,557	,000
	Distance to closest train station	1229,133	937,493	,058	1,311	,194
	Distance to ramp main road	-2170,649	4804,689	-,022	-,452	,653
	Distance to general practice	-16436,649	14071,716	-,065	-1,168	,247
	Distance to hospital	2972,665	889,718	,163	3,341	,001
	Distance to daycare	3878,230	11691,699	,015	,332	,741
	Distance to elementary school	-13209,738	31148,470	-,024	-,424	,673
	Distance to VMBO-school	66,020	4416,634	,001	,015	,988

Distance to HAVO/VWO-school	3372,904	2952,851	,070	1,142	,257
Distance to big supermarket	-30241,671	20132,231	-,093	-1,502	,138
Distance to restaurant	-11908,761	13815,757	-,048	-,862	,392
Distance to library	5124,168	4632,877	,056	1,106	,273
Distance to cinema	-1434,037	872,703	-,087	-1,643	,105
Distance to swimming pool	243,436	2417,187	,006	,101	,920
Average income per household excluding students	10,380	,527	1,066	19,692	,000
Average floor space per municipality	568,702	157,009	,204	3,622	,001
Percentage of the municipality that is owner-occupied houses	-1632,218	343,453	-,337	-4,752	,000

a. Dependent Variable: Average house price per municipality.

b. Selecting only cases for which The municipality is urban = Urban.

Table 16: Regression 2 - Coefficients table

8c: Regression for the effect of mobility on house prices in suburban areas within the Netherlands

Model Summary

Model	R The municipality is sub-urban = Sub-urban (Selected)	R Square	Adjusted R Square	Std. Error of the Estimate
1	,904[a]	,818	,764	20761,381

a. Predictors: (Constant), Percentage of the municipality that is owner-occupied houses, Distance to cinema, Distance to restaurant, Distance to ramp main road , Distance to swimming pool, Distance to elementary school, Distance to daycare, Average floor space per municipality, Distance to closest train station, Distance to HAVO/VWO-school, Distance to hospital, Distance to library, Distance to big supermarket, Average income per household excluding students, Distance to general practice, Distance to VMBO-school.

Table 17: Regression 3 - Model summary

ANOVA[a,b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	104569690345,303	16	6535605646,581	15,163	,000[c]
	Residual	23275887119,486	54	431034946,657		
	Total	127845577464,789	70			

a. Dependent Variable: Average house price per municipality.

b. Selecting only cases for which The municipality is sub-urban = Sub-urban.

c. Predictors: (Constant), Percentage of the municipality that is owner-occupied houses, Distance to cinema, Distance to restaurant, Distance to ramp main road , Distance to swimming pool, Distance to elementary school, Distance to daycare, Average floor space per municipality, Distance to closest train station, Distance to HAVO/VWO-school, Distance to hospital, Distance to library, Distance to big supermarket, Average income per household excluding students, Distance to general practice, Distance to VMBO-school.

Table 18: Regression 3 - ANOVA table

Coefficients[a,b]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	-76335,376	43723,046		-1,746	,087

	Distance to closest train station	25,984	769,792	,002	,034	,973
	Distance to ramp main road	-7704,091	7226,324	-,070	-1,066	,291
	Distance to general practice	4929,304	14005,993	,030	,352	,726
	Distance to hospital	-112,139	669,868	-,012	-,167	,868
	Distance to daycare	-9248,445	10702,641	-,057	-,864	,391
	Distance to elementary school	-41344,507	28887,479	-,105	-1,431	,158
	Distance to VMBO-school	2438,143	4173,842	,064	,584	,562
	Distance to HAVO/VWO-school	-1169,965	3540,540	-,036	-,330	,742
	Distance to big supermarket	9057,376	19993,430	,037	,453	,652
	Distance to restaurant	-21860,039	17103,200	-,111	-1,278	,207
	Distance to library	2011,081	6177,931	,025	,326	,746
	Distance to cinema	535,466	698,454	,057	,767	,447
	Distance to swimming pool	11,229	2930,853	,000	,004	,997
	Average income per household excluding students	8,273	,775	,880	10,673	,000
	Average floor space per municipality	89,260	195,640	,035	,456	,650
	Percentage of the municipality that is owner-occupied houses	-252,505	607,726	-,037	-,415	,679

a. Dependent Variable: Average house price per municipality.

b. Selecting only cases for which The municipality is sub-urban = Sub-urban.

Table 19: Regression 3 - Coefficient table

8d: Regression for the effect of mobility on house prices in rural areas within the Netherlands

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the

	The municipality is rural = Rural (Selected)			Estimate
1	,915[a]	,838	,823	18128,884

a. Predictors: (Constant), Percentage of the municipality that is owner-occupied houses, Distance to cinema, Distance to ramp main road , Distance to VMBO-school, Distance to elementary school, Average income per household excluding students, Distance to restaurant, Distance to closest train station, Distance to library, Distance to daycare, Average floor space per municipality, Distance to swimming pool, Distance to big supermarket, Distance to hospital, Distance to HAVO/VWO-school, Distance to general practice.

Table 20: Regression 4 - Model summary

ANOVA[a,b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	292087834809,593	16	18255489675,600	55,546	,000[c]
	Residual	56528905931,148	172	328656429,832		
	Total	348616740740,741	188			

a. Dependent Variable: Average house price per municipality.

b. Selecting only cases for which The municipality is rural = Rural.

c. Predictors: (Constant), Percentage of the municipality that is owner-occupied houses, Distance to cinema, Distance to ramp main road , Distance to VMBO-school, Distance to elementary school, Average income per household excluding students, Distance to restaurant, Distance to closest train station, Distance to library, Distance to daycare, Average floor space per municipality, Distance to swimming pool, Distance to big supermarket, Distance to hospital, Distance to HAVO/VWO-school, Distance to general practice.

Table 21: Regression 4 - ANOVA table

Coefficients[a,b]

		Unstandardized Coefficients		Standardized Coefficients		
Model		B	Std. Error	Beta	t	Sig.
1	(Constant)	-252695,384	24219,583		-10,434	,000
	Distance to closest train station	-266,630	417,028	-,023	-,639	,523
	Distance to ramp main road	5294,621	2870,026	,059	1,845	,067

	Distance to general practice	25067,286	5755,314	,217	4,356	,000
	Distance to hospital	1334,247	477,062	,131	2,797	,006
	Distance to daycare	-5050,401	2606,495	-,072	-1,938	,054
	Distance to elementary school	4088,711	10817,059	,015	,378	,706
	Distance to VMBO-school	-655,333	885,322	-,033	-,740	,460
	Distance to HAVO/VWO-school	344,006	760,490	,022	,452	,652
	Distance to big supermarket	-9586,733	5519,633	-,084	-1,737	,084
	Distance to restaurant	-10435,688	4000,224	-,095	-2,609	,010
	Distance to library	584,141	1010,376	,021	,578	,564
	Distance to cinema	-873,841	480,443	-,086	-1,819	,071
	Distance to swimming pool	-350,419	620,658	-,023	-,565	,573
	Average income per household excluding students	10,977	,438	,933	25,085	,000
	Average floor space per municipality	109,704	75,442	,054	1,454	,148
	Percentage of the municipality that is owner-occupied houses	-240,511	254,095	-,035	-,947	,345

a. Dependent Variable: Average house price per municipality.

b. Selecting only cases for which The municipality is rural = Rural.

Table 22: Regression 4 - Coefficient table