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Housing Market Anticipation Effects of West Metro’s Second Phase

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Abstract

This thesis analyses how anticipations of the second phase of the metro line extension project, called "West Metro", have impacted apartment prices and demographics during its construction period from December 2014 until the end of 2021. The hedonic difference-in-difference method shows that anticipations have significantly increased apartment prices by 7.93 % within 800 metres from the stations, respectively by 6.61 % within 800–1 600 metres and 3.88 % within 1 600–2 000 metres. Demographic changes in the share of highly educated residents and mean income have been graphically analysed on a postal code level, and there have been no noticeable changes in the trends.

Compared to the first phase of the line, anticipations in the second phase are more extensive and extend even further from the stations. (Harjunen, 2018). This is likely due to improved information about the metro and its impact on the neighbourhood. Thus, the first phase has been in operative use since November 2017.

The results are supported by previous research that generally agrees that improvements in public transportation positively impact real estate prices.

Keywords West Metro, Länsimetro, public transportation, Economics

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Sammandrag

Utvidgningen av Helsinforsmetron till Esbo, Västmetron, byggs i två faser och denna avhandling undersöker hur förväntningarna på dess andra fas har påverkat bostadspriserna och demografin vid de nya metrostationerna. Undersökningstiden är fr.o.m. byggarbetets början i december 2014 tills slutet av 2021.

Statistiska metoden hedonisk difference-in-difference, visar att lägenhetspriserna har stigit signifikant med 7,93 % inom 800 meter från de nya stationerna, och respektive med 6,61 % inom 800–1 600 meter och 3,88 % inom 1 600–2 000 meter. En grafisk analys på basis av data på postnummernivå, visar att utvecklingen i andelen högutbildade personer och medianinkomst, har inte utmärkande ändrats vid stationsområdena.

I jämförelse med projektets första fas, är förväntningarna på den andra fasen positivt högre och prisökningen sträcker sig längre från stationerna. (Harjunen, 2018). De högre prisökningarna kan förklaras med ökad information bland konsumenterna om metron och dess följder på grannskapet, då linjens första del har varit i operativt bruk sen november 2017.

Resultaten understöds av tidigare undersökning som generellt tyder på att investeringar i kollektivtrafik ökar på lägenheternas efterfråga.

Nyckelord Västmetro, Nationalekonomi, kollektivtrafik

Contents

1 Introduction

This thesis studies how anticipations of the new metro line extension from Helsinki to Espoo, called West Metro, have influenced housing prices and demographics before the metro has been taken into use. The new line is built in two phases, and this research focuses on the second phase of the line, which is estimated to be completed at the beginning of 2023.

As a neighbouring city to Helsinki, Espoo faces growth pressure, and the metro is built to provide functioning means of transportation and limit congestion. In order to maximise the metro utilisation, are the station areas zoned to become more densely populated. The increased amount of transiting people will also attract more business services, and the neighbourhoods will become more urban. There have been opposing opinions about the neighbourhood development, e.g., in form of official appeals. Anticipations are not solely formed by the new public transportation but rather about all expected changes that coincide with West Metro's second phase.

The change in real estate prices due to anticipations are analysed through a hedonic difference-in-difference approach, with a control group consisting of apartments near railway stations in Espoo. The results show that anticipations have increased apartment prices significantly by 7.93 % within 800 metres from the new stations and respectively by 6.61 % in the distance of 800–1 600 metres. Anticipations influence prices less the further you go from the stations, and in the 1 600–2 000-metre radius, the price increase caused by expectations plunges to 3.88 %. Anticipations are analysed from the beginning of construction in mid-December 2014 until the end of 2021.

Compared with the first phase of the line, are apartment buyers now more positively anticipating the new line, and the effect extends even further from the stations. Harjunen (2018) concludes that anticipations of West Metro's first phase increased real estate prices by 4.0 % within 800 metres of the stations. Further from the stations, the effects were insignificant. Since the first phase of the West Metro is already in function, people now have an example of how the metro will change the neighbourhood and public transportation. This improved knowledge is expected to have influenced expectations towards the second line. It is important to keep in mind that the difference in anticipations between the two phases does not reveal the overall price change caused by the metro. Prices are likely to continue to be impacted by the metro when it is taken into use.

Demographic changes are graphically analysed by comparing the trends in the share of highly educated residents and median income in control- and treatment groups. Based on the illustrations, we cannot identify any noticeable differences in trends between the groups. Therefore, the anticipated metro has not disproportionally attracted residents from specific income- or educational classes.

The results support that residents benefit from a new metro station in the neighbourhood; thus, it positively influences their bids set on the apartments. The additional value-added for the residents is important when the metro is publicly financed, and its overall costs are estimated to reach 2 345 million euros. (Länsimetro, 2022).

Several previous studies have researched the relationship between real estate prices and public transportation, e.g. (Bowes, Ihlanfeldt, 2001) (Kheyroddin, Taghvaee, Forouhar, 2014). The general conclusion is that prices increase closer to transit stations. However, most studies in the field are not quasi-experiments and do not prove causality but rather a positive correlation. In addition, few studies have focused on the Finnish real estate market.

2 Background

2.1 Metro line, timeline, and costs

West Metro is a metro line extension from Helsinki to its neighbouring city Espoo. Metro line extensions are atypical in Finland, and this is the first metro line outside the capital. The project has been both costly and time-consuming—only the construction period is estimated to last 13 years. The project is completed in two phases, and figure 1 illustrates the complete line. The line constructed in the first phase extends from Ruoholahti, Helsinki, to Matinkylä, Espoo and the second phase is from Matinkylä, Espoo, to Kivenlahti, Espoo.

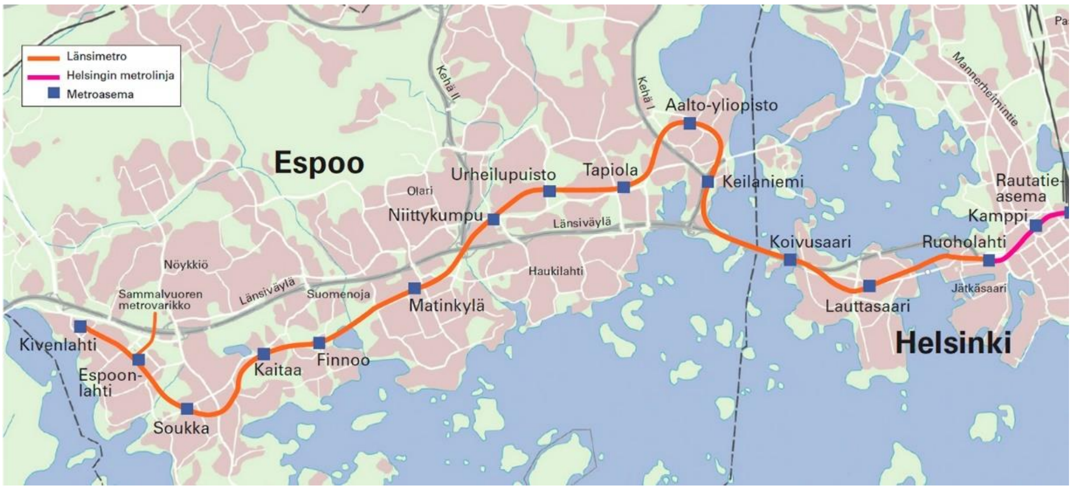

Fig. 1. West Metro (source: Länsimetro, 2022)

In November 2009, the construction of the first phase began, and the metro started operating eight years later, in November 2017. Subsequently, the second phase of construction commenced in mid-December 2014, and it is estimated to be completed at the beginning of 2023. The station locations of the second phase been public information since May 2012. Figure 2 illustrates the timeline for the second phase. After the line is completed, Helsinki City Transport (HKL) is responsible for the metro's operative use. (Länsimetro, 2022)

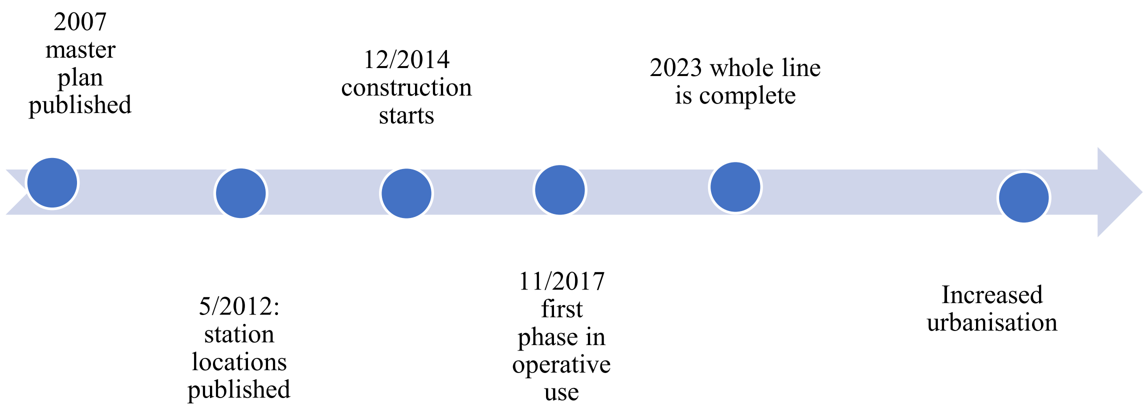

Fig. 2. Timeline for West Metro's second phase

The whole line is being built underground, and once the metro starts running, it cannot be heard or seen by the residents. (Länsimetro, 2022). The line itself will not have any externalities, and only the stations will signal about the metro.

West Metro has been a costly infrastructure project. The costs of the first phase exceeded the budget of 714 million by far, with realised costs of 1 186 million euros. The second phase costs are estimated to be equally large at 1 159 million euros. In addition to the fixed costs, the yearly running costs of the whole line are estimated to be 20 million euros, but ticket fees will broadly cover this. (Länsimetro, 2022). For a reference to the costs, Raide-Jokeri, an ongoing light-railway line project, is estimated to cost 386 million euros, even when it will be 4 kilometres longer than the new metro line. (Raidejokeri, 2022)

It is unclear if the metro will bring cost savings to public transportation. Straight bus lines to Helsinki have been cancelled, but they are instead rerouted to the new stations. (Yle, 2018)

2.2 Increased density

One of the main arguments for the metro is to tackle the expected congestion that arises from population growth in Espoo. Together with the metro, are the station areas zoned to become more urbanised and host more residents. This makes the metro less dependent on feeder traffic and ensures efficient use of the new public transportation. Below are listed per area how they will be developed, and figure 1 shows their location on a map.

- **Finnoo** will have new apartments for 17 000 new residents before 2030. Finnoo is investing in more public facilities, such as schools, day-care, and playgrounds, to provide services for all residents. The station entrances will become lively and have two marketplaces. (Espoo, 2021)

- **Kaitaa**'s zoning plan is not yet legitimate, but the preliminary plan is to have new apartments for 1 000 new residents in the absolute station vicinity and other housing development further away. Kaitaa is mostly a detached housing neighbourhood, and the high-rise apartments will change the neighbourhood's appearance. Two parking halls will be built by the station to ensure car connectivity. (Espoo, 2021)

- **Soukka** will have infill housing development in the immediate vicinity of the station, and a parkin hall will replace an existing parking lot. The city council expects 5 600 new residents to move within 600 metres radius of the station. It is still undecided if the old housing will be torn down or if all new housing is infill housing. (Länsiväylä, 2021)

- **Espoonlahti** is zoned to have high-rise apartments for 12 000 new residents by 2050, and a large shopping centre, "Lippulaiva", is currently being built by the station. (Länsimetro, 2022).

- **Kivenlahti** will have apartments for 12 000 new residents and workplaces for 2 000 persons. (Länsimetro, 2022).

Most of Espoo's investment money is allocated to the station-areas' development; thus, new roads, bridges, and public facilities must be built to deal with the population growth. (Yle, 2020)

2.3 Public reception

How people appreciate the new development in Espoo is ambiguous, and it has sparked much debate in the media. Official appeals against both the metro and zoning have been brought forward. An appeal against the metro was brought to the Finnish Supreme Administrative Court, which delayed the construction of the first phase by a year. (HS, 2013b) Additionally, Kaitaa's zoning plans have not yet come into force because of an ongoing appeal in Helsinki Administrative Court. (Espoo, 2021b).

Many worries that increased urbanisation will change the neighbourhoods and destroy nature. But people differ in preferences, and many value the improvements in public transportation and neighbourhoods becoming more urban and vivid. (HS, 2013a).

In 2008 during West Metro's planning phase, there was lobbying for a light-railway line as an alternative to the metro. The initiative was set by a self-organised group called "Tramwest", and they received presence in the media. They argued that the metro relies too much on feeder bus traffic when in 2008 only 15 000 people lived within walking distance of the planned metro stations. A light railway line instead would enable more stations and thereby cover more residents. (HS, 2008)

Overall, West Metro has received much media presence since its planning phase, and it is safe to say that Finns are well informed about it. The high awareness of the project is likely to enhance people's anticipations.

2.4 Effects on commuting

West Metro's first phase is an excellent example of how commuting will change in Espoo—straight bus lines to Helsinki have been revoked, and buses are instead rerouted to the stations. (HSL, 2021)

Hence the metro relies on feeder bus traffic, and commuters must take connecting buses; the new metro has not succeeded in shortening commuting times for all residents. Figure 3 shows the areas close to Matinkylä-, Niittykumpu- and Tapiola metro stations and only in the absolute station vicinity have commuting times to Helsinki city centre shortened. Further away, the effects are unclear, and in many places, commuting times have even been prolonged by over 8 minutes. (HS, 2018) Failure to improve commuting times can negatively influence anticipations of the line built in the second phase. Regarding comfortability, some may prefer the metro over the bus, even if the commuting time does not change.

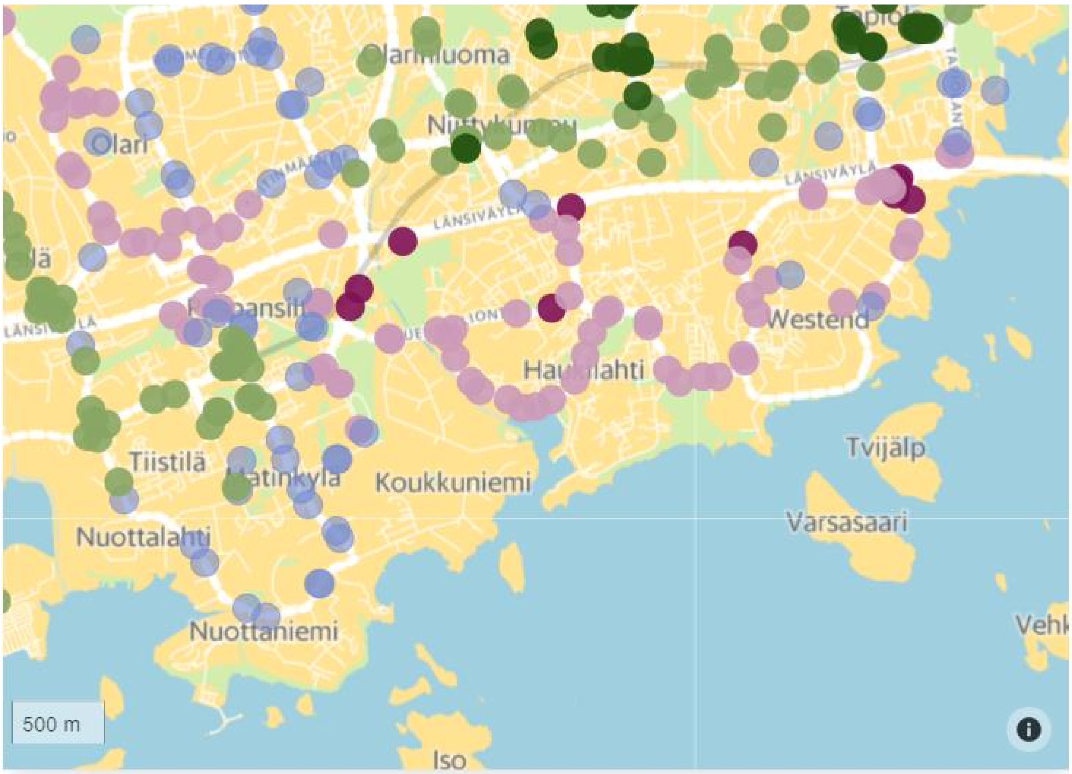

Fig. 3. Change in commuting times to Helsinki city centre (source: HS, 2018)

Notes: Commuting times to Helsinki City Centre has:
Shortened > 8 min. Shortened 2–8 min. Change 0–2 min. Prolonged 2–8 min. Prolonged > 8 min

No scientific research has investigated whether West Metro has caused more people to switch from private- to public transportation. Only the Finnish broadcasting company "Yle" has published that Länsiväylä, the motorway parallel to West Metro, had 4.6 % less traffic after the metro was taken into use. (Yle, 2018) This is primarily due to bus lines being replaced by the metro. On the other hand, private car traffic decreased only by 0.9 %. The changes are estimated by comparing traffic a couple of months before and after West Metro started operating, and it does not prove causality. Seasonal changes can have impacted private car use, but a fall in bus traffic along Länsiväylä is to remain.

3 Literature review

Real estate prices' reaction to improvements in public transportation is a frequently researched topic. The common ground is that real estate becomes more valuable with improvements in public transportation and the effects vary depending on the neighbourhood's original state.

When studying transit stations, it is important to note that they directly and indirectly affect real estate prices. Directly by improving commuting, and indirectly by attracting more services to the area, while transiting people increases the customer base for businesses.

Regression models using cross sectional data have been broadly used in the existing literature to estimate the impact of transit stations on real estate prices. This means in practice, that data is collected from a single point of time and the analysis looks at how real estate prices change with distance to transit stations. The common ground is that apartments tend to be more valuable closer to transit stations, and the magnitude differs between areas. (Bowes, Ihlanfeldt, 2001; Kheyroddin, Taghvaee, Forouhar, 2014; Wlech, Gehrke, Farber, 2018; Cordera, Coppola, dell'Olio, Ibeas, 2019) A weakness with this approach is that transit stations correlate with unobserved factors that affect the price. This is due to transit stations not being randomly allocated, and the neighbourhoods change with the distance to stations. Also, the neighbourhoods may develop differently over time because of an existing transit station. Even if the models include many controls, they are unlikely to capture all objectives that explain an apartment's price. Due to the above-mentioned weaknesses of regression models with cross-sectional data, this literature review will focus on quasi-experimental studies that analyse prices before and after an intervention and prove causality without randomly assigning the treatment.

3.1 Global findings

Gupta, Nieuwerburgh and Kontokosta (2021) researched how real estate- and rental prices react to a metro line extension in New York City. The empirical method is difference-in-difference, and the control group consists of other neighbourhoods in the same city. The results show that half of the price gain in real estate occurred during the construction period, while rental prices increased only after the metro line was completed. This is because rents are spot priced and reflect the current housing circumstances. Overall, real estate prices increased 5–10 % depending on the location. The demand for different apartment types was asymmetrically affected by the metro, and new housing experienced the most significant price gains. The apartments were disproportionately higher demanded among consumers who were more likely to use the new metro line, and their high bids drove up the prices. Based on mobile phone tracking data, commuting times did decrease significantly, and thus, the metro successfully improved public transportation. They conclude that improvements in public transit lower the risk of owning an apartment in the neighbourhood, which can attract more retail investors. This research is unique because it can almost entirely distinguish the metro's independent impact on housing prices. This is because New York City is unlikely to change due to the metro extension—the housing supply is highly inelastic, and the city is already highly urban.

Devaux, Dubé and Apparici (2017) researched how Montreal's metro line extension to the neighbouring city of Levain influenced housing prices. The empirical method applied is spatial difference-in-difference based on repeat sales data. Repeat sales data consist of retail price data for the same real estate sold in different periods. The periods analysed are the announcement-, construction-, and operation of the new metro line. Surprisingly, only housing prices in the most densely populated station area reacted positively in the operation period, and the other regions were insignificantly affected in all periods. Contrary to most research papers, the dataset consists only of single-family housing. Households in single-family houses are often families with children, and they may be less likely to travel by metro.

Instead of analysing price changes before and after a transit station is constructed, Welch, Gehrke and Farber (2018) studied how transit stations contribute to retaining real estate value. In the aftermath of the 2007 financial crisis, real estate prices fell sharply in the US. The authors show with repeat sales analysis that apartments closer to railway stations depreciated less than those further away. The studied cities were

Atlanta, Georgia; Baltimore, Maryland; and Portland, Oregon, and all cities experienced similar patterns.

In Espoo, the metro line extension coincides with infill housing development, which may further influence housing prices. A study by Ooi and Lee (2012) shows that new housing construction refreshes neighbourhoods and attracts new residents. New real estate is generally pricier, which leads to a higher income level among the new residents. Whereas the opposite happens if the housing development consists of low-income housing projects. The new housing may have positive spillovers on prices of the existing housing, and spillovers tend to be larger if new housing is built on torn down areas instead of diminishing recreational areas. If the supply grows faster than the demand, the price pressure is expected to dampen. As previously mentioned, the housing stock in Espoo is going to increase substantially in the following decades, and this may lower price pressure in the long run.

3.2 Finland

Harjunen (2018) has analysed with hedonic difference-in-difference how anticipations of West Metro's first phase influenced real estate prices. This empirical design will be replicated in my thesis to better compare the first- and the second phase. During the construction phase, anticipations raised housing prices by 4 % within 800 metres of the new stations and further away, the effects were insignificant. Anticipations started to significantly influence prices with a one-year delay from the launch of construction. The control group consisted of apartments near railway stations in Espoo and Helsinki. Based on these results, we can assume the prices to appreciate in the second phase.

Only one other paper has studied real estate prices in West Metro's second phase areas. (Manninen, 2021). The method used is OLS regression, and the predicted price increases are remarkably more extensive than in the paper by Harjunen (2018). Conditional to the station, apartments in the 800-metre station radius are expected to see a yearly real price increase of 1.61–11.27 % in the years prior to the metro's completion. E.g., Apartments in Soukka are expected to become 21.44 % pricier in 2023 when West Metro starts operating. The OLS regression is not a quasi-experiment but rather a prediction that does not show what would happen in the absence of treatment. The regression includes covariates for predicted economic figures, and false predictions will bias the results. The large, predicted price changes demonstrate the need for further research with other methods.

Besides West Metro, another public transportation line called "Raide-Jokeri" is under development in Espoo. It is a high-speed light railway line from east Espoo to east Helsinki. Kauria (2020) estimated the anticipations of the new line, to have increased real estate prices by 6 % within 800 metres from the new stations. The expectations of the new line have statistically significantly started to appreciate prices 5–7 years before the light-railway begins to operate. The empirical method is hedonic difference-in-difference with a control group consisting of apartments further than 800 metres from the stations. The results are biased if the new line affects the control group. The choice of the control group furthermore reinforces the importance of more research about public transportation's causal effect on housing demand in Finland.

Based on the existing literature, we cannot draw any strong conclusions about whether the demographics will change due to the metro. The infill housing development can attract more high-income people who can afford the new apartments. Alternatively, the metro can attract low-income people dependent on public transportation because income is one of the key determinants of car ownership. (Gates et al., 2019)

4 Research design

The following chapter will present the research design for this thesis' empirical part. This empirical research studies how anticipations of the West Metro's second phase have impacted apartment sales prices. The analysis will answer whether the expected benefits of the new metro line are embedded in the real estate prices before the metro is taken into use.

West Metro's second phase establishment can be divided into announcement-, construction- and operation period, and this research focuses on the construction period. Apartment sales prices are analysed from the beginning of construction the 14th of December 2014 until the end of 2021. Construction is estimated to continue until the beginning of 2023 and prices may continue to change during the last year of construction. (Länsimetro, 2022)

As previously mentioned, West Metro is expected to coincide with other neighbourhood development, and we cannot distinguish expectations regarding improvements in public transportation from other developments in the region.

Price changes are analysed with a hedonic difference-in-difference approach, meaning that by comparing price changes to a reference group when controlling for apartment characteristics, we can distinguish the treatment's causal impact on prices. This model relies on the hedonic pricing model theory on how apartment prices are formed. Based on this theory, an apartment's price is a result of a multi-dimensional basket of its internal- and external attributes. Naturally, when these attributes improve, the apartment's value appreciates. Unlike other goods, apartments are not consumed separately from their neighbourhood, and everything that changes the neighbourhood will affect the apartment's attractiveness. (Rosen, 1974). A metro station within walking distance of an apartment is a change in its external attributes.

To allow difference-in-difference comparison between a control- and a treatment group, the groups must be assumed to have parallel trends in the absence of treatment, and the treatment should not have any spillovers on the control group. The treatment here is the new West Metro line being constructed in the second phase. The parallel trends assumption allows for differences in the absolute price level but not in price development. I will indirectly verify the parallel trends assumption by analysing pre-treatment trends in outcome.

This research will use a similar distinction of the control group as Harjunen (2018) when he studied West Metro's first phase. The control group consists of apartments near railway stations in Espoo (Kauklahti, Tuomarila, Espoonkeskus, Kera, Kilo and Mäkkylä). I will exclude Leppävaara due to its proximity to the other public transportation project Raide-Jokeri, which is expected to influence housing demand. When the treatment- and control group are in the same city, it ensures similar demand shocks on real estate. In addition to the location in the same municipality, the zoning is similar close to railway- and metro stations and the housing consists mainly of apartment buildings. The groups' geographical distance from each other ensures no spillovers from the neighbourhood development and makes it less likely for the control group residents to take the metro. It is more optimal for the control group residents to travel by train to Helsinki. Also, the public transportation will not change in the control group areas. (HSL, 2021)

Overall anticipation effects are estimated with the hedonic difference-in-difference formula:

$$Log(Sale\ price)_{it} = \alpha + \beta \times treatment_i + \gamma \times treatment_i \times after_t + \partial X_{it} + \varepsilon_{it} \quad (1)$$

In the formula, "i" is the identification of an apartment and "t" is the year. The main interest lies in the station's effect on prices γ, which receives a value when the apartment is in the treatment group and is sold after the construction has started. X_i is a bundle of apartment characteristics that are controlled for in the analysis.

Internal characteristics that will be controlled for are apartment condition, square size, construction year, number of rooms, floor number, and the number of stories in the building. To control for external characteristics, I will use a dummy for which transit station is located closest to the apartment. Apartments with the same nearest station are assumed to be spatially autocorrelated, meaning their neighbourhood characteristics are alike. Therefore, the dummy for the station will control for neighbourhood characteristics. The hedonic difference-in-difference will be conducted on three distance intervals to the nearest transit station (metro or railway): 0–800 m, 800–1 600 m, and 1 600–2 000 m.

Difference-in-difference will mitigate the potential selection bias that arises from the treatment not being randomly allocated, while metro station location is systematically chosen. Another advantage of this method, compared to linear regression, is that it removes any bias that arises from unidentified shocks, given that the treatment- and control groups face the same shocks. Covid-19 is a good example of a shock that is expected to have impacted both groups similarly.

Residential relocation between the treatment- and control group threatens the model if it weakens demand in the more emigrating group. For instance, if control group residents move significantly more to the new metro areas, the prices used for comparison will overestimate the treatment effect. Nevertheless, no public data is found about migration inside Espoo.

The second part of the empirical research will study if demographics have changed following anticipations of the new metro line. Demographical changes will be graphically analysed by comparing the trends in yearly median income and the share of residents with higher education in control- and treatment group areas. Due to data restrictions, this analysis is done on a postal code level, and the exact station distance is left unobserved. The analysis includes postal codes with control- or treatment group transit stations.

The next chapter will describe the dataset that will be applied in the empirical research.

5 Data

To conduct the study, I will utilise data of sold apartments gathered from the Federation of Real Estate Agency's price monitoring service. (KVKL, 2022) This databank contains apartment characteristics and final debt free sales prices of all sold apartments by the following real estate agencies: Aktia Kiinteistönvälitys, Huoneistokeskus, Kiinteistömaailma, OP Koti, RE/MAX Finland, SP-Koti and Suomen Kiinteistövälittäjät ry. The agencies are market leaders in Finland, and therefore this dataset reflects the actual market situation. The data source is identical for the control- and treatment group apartments.

Housing type is restricted to apartments in apartment houses, and the time scope is 2010—2021. All new apartments constructed after 2010 are left out since the treatment group is expected to have a disproportionally higher number of them. With these delimitations, the dataset consists of 10 772 apartments located within a 2 km radius of a transit station (metro- or railway station).

The distance to the nearest station is a geographical straight-line distance calculated with apartment- and station coordinates. Street address coordinates are gathered from Avoindata-website and station coordinates from Geohack-website. (Avoindata, 2022) (Geohack, 2022)

Potential measurement errors in the observations are mitigated by removing observations with clearly false descriptive values.

Figure 4 illustrates the density of apartments that fulfil the mentioned delimitations. We notice from the figure that observations are not smoothly distributed conditional on the distance to a transit station, and there is a large drop in observations around the 1 km threshold. This is likely due to zoning decisions resulting in apartment buildings being more concentrated in some areas. Additionally, Espoo Central Park is close to railway stations, which restricts housing construction. To prevent potential biases from unharmonised data distribution, apartments are clustered into three distance bounds: 0–800 m and 800–1 600 m 1 600–2 000 m.

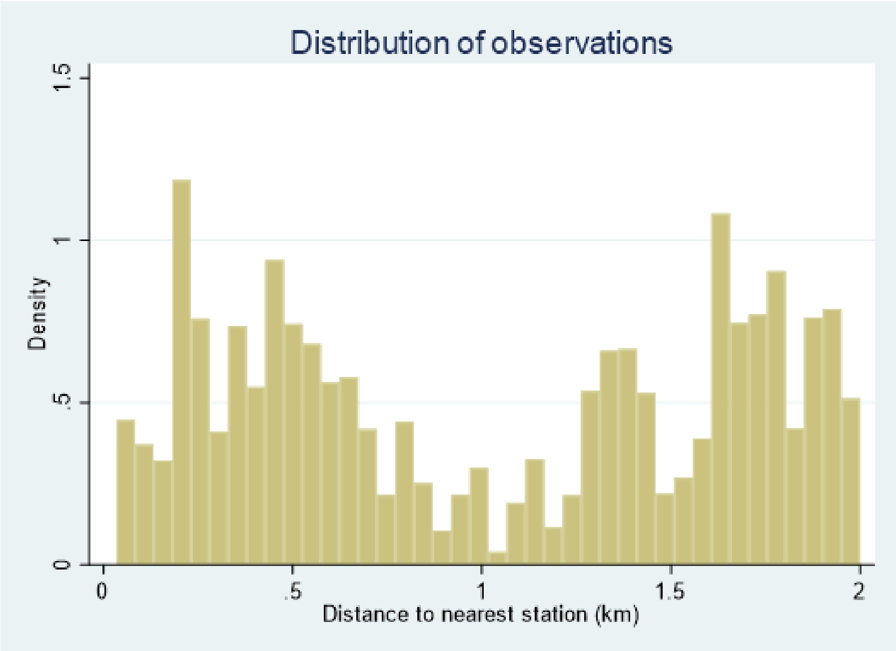

Fig. 4. Density of observations

Table 1 shows the mean descriptive values for apartments in different distance intervals in the control and treatment group. Based on these attributes, the groups do not noticeably differ, making them more likely to experience similar demand shocks. The most noticeable difference is that apartments within 800 metres of a metro station, are on average 12 years older than their reference group. However, the construction year will be controlled for in the analysis.

Table. 1. Descriptive statistics in treatment and control groups

	0–800 m Control	0–800 m Treatment	800–1600 m Control	800–1600 m Treatment	1600–2000 m Control	1600–2000 m Treatment
Sales price €	176474.2	186277.7	182602.4	194363.3	202751.1	213592.3
	(59153.19)	(61288.12)	(59613.05)	(66464.56)	(77291.15)	(70034.82)
Size (sqm)	62.58	66.17	60.53	62.96	64.14	61.25
	(16.51)	(20,62)	(17.02)	(19.22)	(20.23)	(18.93)
Constr. year	1990.70	1978.36	1982.06	1992.45	1985.09	1084.91
	(13.90)	(10.90)	(13.92)	(12.07)	(15.05)	(13.91)
Rooms	2.48	2.52	2.43	2.47	2.54	2.43
	(0.805)	(0.982)	(0.888)	(0.854)	(0.91)	(1.42)
Maint. charge	226.86	258.47	224.90	232.70	240.97	244.58
	(77.23)	(85.55)	(75.89)	(79.79)	(79.44)	(84.60)
Satisfactory	23.85 %	33.46 %	30.76 %	20.33 %	30.10 %	26.05 %
Good	71.48 %	59.52 %	63.57 %	76.74 %	65.85 %	68.79 %
Unknown	2.34 %	3.89 %	2.77 %	1.28 %	1.70 %	1.84 %
Passable	1.97 %	2.69 %	2.55 %	1.28 %	2.04 %	2.36 %
Excellent	0.37 %	0,44 %	0.36 %	0.37 %	0.29 %	0.96 %
Observations	1,627	3,162	2,237	546	2,053	1,144

Data on demographics are collected from the Paavo-database, which is a database updated by Statistics Finland. Demographic attributes used in the analysis are the share of highly educated people and median income. (Paavo-database, 2022) The data is gathered on a postal code level for 2012–2020, with educational data missing for 2015.

6 Results

6.1 Graphical analysis

The following section will graph the price development in the control- and treatment group between 2010 and 2021. The similar trends before treatment support the choice of the control group by indirectly proving that the parallel trends assumption holds.

Figure 5 illustrates the yearly mean logarithmic housing sales price in different distance bounds. The red line visualises the start of construction in the second phase areas. Based on these graphs, the trends in both groups seem to be parallel before the construction starts. In all distance bounds, the price development in the treatment group becomes more positive after construction begins.

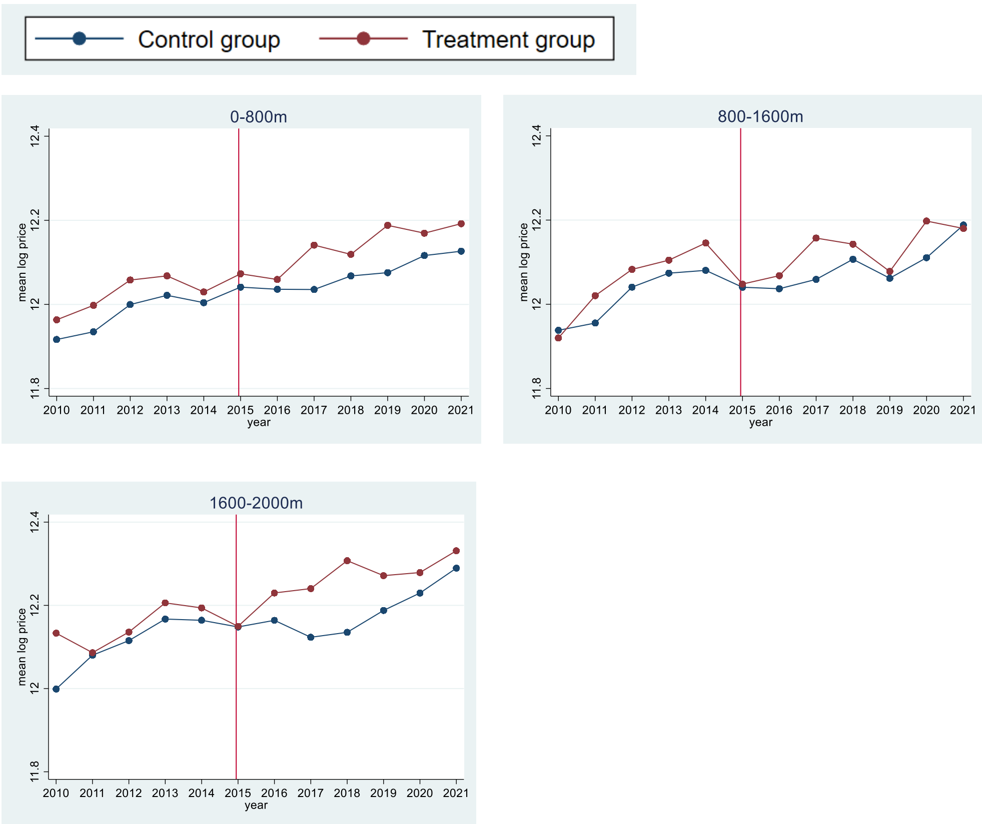

Fig. 5. Sales price development in treatment- and control group

Notes: The vertical red line illustrates the start of the second phase construction.

The second graphical analysis studies whether the price trends are statistically different between the treatment- and control group, when controlling for apartment characteristics. Figure 6 illustrates the yearly anticipation effects in a 95 % confidence interval and 2014 is used as a base value. From the graph, we notice that the treatment estimate is mainly statistically insignificant before construction starts, with an exception for 2010 in the interval of 800–1600 metres and 2010 and 2011 in the interval of 1 600–2 000 metres. The plan for the second phase metro line was not yet determined in 2010 or 2011, and thus the negative shock is caused by something unobserved.

Figure 6 shows that the anticipations start to influence prices a year after construction starts. However, the yearly price increase is not constant depending on the distance bound. Closer to the stations (0–800 m), prices increase the most in 2021, closer to the metro's completion. Whereas further away (800–1 600 m), the largest price increase occurs in 2016, a year after construction starts. In the 1 600–2 000 metre distance, anticipations influenced prices positively only in 2017. The differences in yearly anticipation effects can be due to negative externalities that arise from the ongoing construction work. The construction is likely to last longer in the absolute station vicinity which hurts demand.

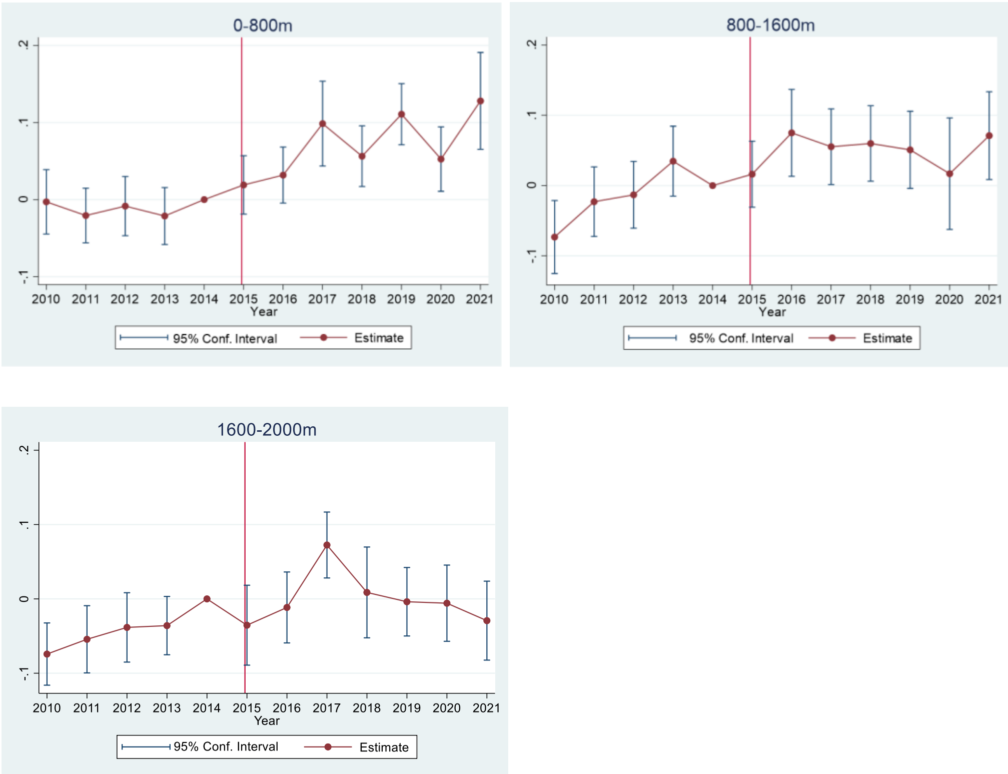

Fig. 6. Yearly anticipation effects

Notes: The vertical red line illustrates the start of the second phase construction. 2014 is used as a base value for the estimate. Standard errors are robust.

6.2 Real estate prices

The hedonic-difference-in-difference model show that anticipations of the West Metro's second phase to have appreciated apartment prices within 2 kilometres from the new stations. Table 2 illustrates the results, and the estimate for anticipation effects is highly statistically significant in all distance bounds. This indicates that consumers perceive the metro stations as something positive, and the expected benefits are already embedded in apartment prices before the metro starts running.

From the results we notice that the largest price increase caused by West Metro occurs closest to the stations within the 800-metre station radius, where anticipations increased prices by 7.93 %. Anticipations are still high in the 800–1 600-metre radius, with anticipation effects of 6.61 %. However, further from the stations, in the 1 600–2 000-metre radius, the anticipation effects fall sharply to 3.88 % and as figure 6 shows, the whole price increase occurs in 2017. While the sales prices are unaffected by the metro in all other periods, it is possible that the price effect is not completely caused by the metro and therefore we cannot conclude that the metro has a significantly affected prices in the distance of 1 600–2 000 metre. This plunge in anticipations demonstrates the importance of proximity to the station.

Table. 2. Hedonic difference-in-difference results

	0–800 m log price	800–1600 m log price	1600–2000 m log price
Treatment × After	0.0793*** (0.00952)	0.0661*** (0.0125)	0.0388*** (0.00959)
Constant	-18.09*** (0.767)	-8.076*** (1.011)	-13.93*** (0.750)
Observations	4,643	2,688	3,082
R-squared	0.779	0.832	0.824

Notes: treatment × after estimate is West Metro second phase's impact on apartment prices during 12.12.2014-31.12.2021. Robust standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

When interpreting the results, it is good to keep in mind that the metro neighbourhoods are facing much construction work, which may influence price development negatively. Thus, construction has negative externalities in the form of noise and view of construction sites.

6.3 Demographic changes

Demographic changes are evaluated by comparing the development in median income and share of highly educated residents to areas without a new metro station. Figures 7 plot the demographic changes in the treatment- and control group and based on the graphs, the trends seem to be parallel before and after metro development begins. This graphical analysis indicates that anticipations of the new metro line have not attracted disproportionately more people from some income- or educational classes.

Demographics may change after the metro line is complete. For instance, if people who are more dependent on public transportation wait until the metro starts operating, or if the original residents move when the areas become more densely populated and congested by commuters.

Residential data on a coordinate- or street level is required to prove causality. This thesis only proposes that anticipations have not remarkably influenced the demographics.

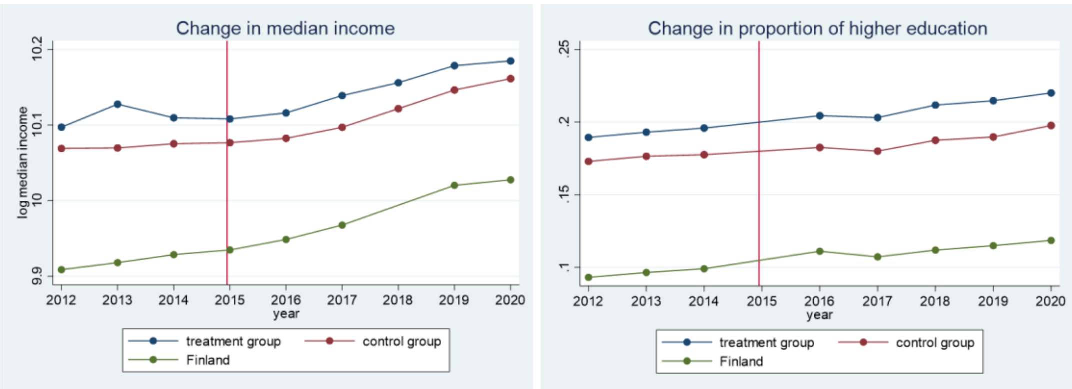

Fig. 7. Demographic changes

Notes: The vertical red line illustrates the start of the second phase construction.

7 Discussion

This section discusses the results and the differences between West Metro's first- and second phase. Here, we compare only the price changes arising from anticipations and not West Metro's overall impact on prices. Prices may continue to react after the metro is completed, and the price changes in the operative period can differ between the first- and second phase of the line.

During the first phase of construction, only apartments within 800 metres from the stations reacted significantly, and prices rose by 4 %. (Harjunen, 2018) The more considerable positive anticipations are likely due to improved information about the metro and its consequences. Hence, the first phase of the line is in operative use during the construction of the second phase. In addition, the housing density will grow more in the second phase neighbourhoods than in the first phase areas, and this is likely to significantly improve the services around the second phase metro stations.

Nevertheless, these two studies are not fully comparable with each other because Harjunen (2018) includes row housing. Residents who purchase different apartment types may have different attitudes towards the new development, which may explain some of the differences in outcome.

In both phases, we identify a one-year time lag between the beginning of construction and an increase in real estate prices. The information of the planning- and construction has been public information during the whole process, but still, construction seems to be a larger signal about the development. It is also time-consuming to find a suitable apartment willing to invest in.

From the dataset, we cannot identify if the higher bids are set by investors or residents. If the price increase results from investors' positive anticipations, it only indirectly signals residential satisfaction because rational investors purchase apartments demanded by tenants. Real estate bought for investment purposes are often apartments that are smaller in size, and weaker anticipations in the first phase could partially be explained by the inclusion of row housing.

Harjunen did not study the demographic changes, except for car ownership rate, which did not change between the control- and treatment group. Based on the results from both studies, anticipations of a metro station do not seem to change the demographics in Espoo.

8 Conclusions

This study concludes that people on average, value living near a metro station and pay more for this amenity. Consumers are forward-looking and can anticipate the new metro stations constructed in the West Metro's second phase. One year before the metro starts operating, apartment prices have already increased due to the metro by 7.93 % within 800 metres from the stations and respectively by 6.61 % and 3,88 % within 800-1 600 and 1 600-2 000 metres. The weaker anticipations further from the stations demonstrates the importance of proximity to the stations.

The empirical analysis is a quasi-experiment conducted with the hedonic difference-in-difference method. The control group consists of apartments close to railway stations in Espoo. These neighbourhoods are assumed to be unaffected by the metro, thus it is suboptimal for the residents to travel by metro when they can take the train. In addition, they are geographically distant from the new metro stations. The control- and treatment groups' similar pre-treatment trends support the assumption of parallel trends in the absence of treatment. The apartment dataset used in the analysis is broad and covers sales data and apartment characteristics for over 10 000 apartments.

Compared to the first phase, consumers anticipate the second phase more positively, and the effects extend further from the stations. This is likely because consumers are now better informed about the metro development since the first phase of the West Metro has been in operative use since 2017. Also, the housing density will grow more in the second phase neighbourhoods, which leads to improvements in services. In the first phase, anticipations affected apartment prices by 4 % only in the 800 metres station radius and further away, the effects were insignificant. (Harjunen, 2018). Nevertheless, anticipations start influencing prices in both phases one year after construction begins. The one-year time lag is presumably since, further in the construction work, the metro development becomes more visible, and it is time consuming to find a suitable apartment.

Based on a graphical analysis on the trends in the share of highly educated residents and median income, there are no remarkable differences between the treatment- and control group before or after the construction takes place. The trends are analysed on a postal code level, and distance to the station is ignored. More data on a coordinate level is required for a more comprehensive study on demographic changes.

Future studies should analyse the relationship between commuting times and apartment prices, to identify whether the public transportation or neighbourhood development has caused most of the increase in apartment prices. If the metro does not bring significantly additional value to the residents, then neighbourhood development is achievable without a costly metro line.

To enable more efficient public transit projects in the future, it should be assessed whether another means of transportation is more suitable in Finland in terms of cost-effectiveness and sustainability. For a comparison to West Metro, the construction costs for the light-railway line "Raide-Jokeri" are 386 million euros, when West Metro will cost 2 345 million euros. The costs are lower, even though Raide-Jokeri will be 4 kilometres longer and have more stations. The higher number of stations improves access for more commuters and makes Raide-Jokeri less reliant on feeder bus traffic. (Raidejokeri, 2022) (Länsimetro, 2022)

To conclude, this paper demonstrates that people's expectations can significantly influence real estate prices, and real-life examples can play a crucial role in forming them. The significant price increase during the construction phase makes it possible that most of the price gain caused by the metro occurs before the metro is complete. However, the future will tell.

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9 Appendixes

Table A1. Estimation results

VARIABLES	0–400 m logprice	400–800 m logprice	800–1200 m logprice	1200–1600 m logprice	1600–2000 m logprice	0–800 m logprice	800–1600 m logprice
Size (sqm)	0.00926***	0.0124***	0.00592**	0.0119***	0.00744***	0.0110***	0.00995***
	(0.000603)	(0.000940)	(0.00240)	(0.00133)	(0.00254)	(0.000704)	(0.00134)
Constr. year	0.0141***	0.0141***	0.0122***	0.00887***	0.0129***	0.0149***	0.00990***
	(0.000438)	(0.000528)	(0.000845)	(0.000550)	(0.000388)	(0.000387)	(0.000510)
Rooms	0.0130	0.0139	0.0545	0.0808***	0.0297*	0.0180**	0.0775***
	(0.0103)	(0.0134)	(0.0486)	(0.0152)	(0.0179)	(0.00894)	(0.0185)
Maint. charge	-0.000157*	-0.00120***	7.32e-05	-0.00164***	0.000297	-0.000771***	-0.00122***
	(8.79e-05)	(0.000260)	(0.000162)	(0.000371)	(0.000445)	(0.000205)	(0.000334)
Soukka	0.0818***	-0.0762***	0.0148			-0.0623***	0.131***
	(0.0166)	(0.0170)	(0.0754)			(0.0156)	(0.0287)
Kivenlahti	0.0314***	0.183***	0.00980	-0.0733***	-0.161***	0.0991***	-0.153***
	(0.00795)	(0.0127)	(0.0374)	(0.0139)	(0.0172)	(0.00787)	(0.0251)
Espoonlahti	-0.0132	-0.188***	-0.0493			-0.181***	0.0571**
	(0.0132)	(0.0166)	(0.0575)			(0.0153)	(0.0267)
Kaitaa	0.119***	-0.103***				-0.0268	
	(0.0178)	(0.0230)				(0.0180)	
omitted.finnoo	-						
omitted.kauklahti	-				-		
Tuomarila	-0.0911***	-0.356***	-0.274***	-0.169***	-0.150***	-0.309***	-0.202***
	(0.0134)	(0.0153)	(0.0491)	(0.0100)	(0.0234)	(0.0142)	(0.0100)
Espoonkesk	-0.0370**	-0.316***	-0.379***	-0.181***	-0.444***	-0.286***	-0.317***
	(0.0177)	(0.0179)	(0.0339)	(0.0184)	(0.0118)	(0.0164)	(0.0114)
omitted.kera	-	-				-	
omitted.mäkkylä	-	-	-	-	-	-	-
satisfactory	-0.193***	-0.0629***	-0.0986***	-0.133***	-0.152***	-0.0986*	-0.135***
	(0.0546)	(0.0168)	(0.0196)	(0.0449)	(0.0276)	(0.0506)	(0.0298)

good	-0.0845	0.0506***	-0.00780	-0.0327	-0.0504*	0.0115	-0.0332
	(0.0545)	(0.0160)	(0.0197)	(0.0447)	(0.0273)	(0.0505)	(0.0296)
unknown	-0.149***	-0.0258	-0.0316	-0.0734	-0.0587*	-0.0517	-0.0592*
	(0.0562)	(0.0229)	(0.0306)	(0.0477)	(0.0329)	(0.0517)	(0.0328)
passable	-0.291***	-0.165***	-0.209***	-0.233***	-0.246***	-0.201***	-0.240***
	(0.0574)	(0.0239)	(0.0318)	(0.0494)	(0.0317)	(0.0521)	(0.0335)
omitted.excellent	-		-	-	-		-
2011.year	0.00662	0.0198	0.0311*	0.0594***	0.0173	0.0165*	0.0504***
	(0.0114)	(0.0138)	(0.0181)	(0.0116)	(0.0107)	(0.00960)	(0.0101)
2012.year	0.0442***	0.0754***	0.0577***	0.121***	0.0483***	0.0659***	0.106***
	(0.0118)	(0.0162)	(0.0184)	(0.0138)	(0.0151)	(0.0112)	(0.0122)
2013.year	0.0792***	0.103***	0.107***	0.164***	0.0566***	0.0992***	0.149***
	(0.0127)	(0.0171)	(0.0178)	(0.0185)	(0.0212)	(0.0121)	(0.0154)
2014.year	0.0739***	0.0961***	0.102***	0.177***	0.0396	0.0896***	0.159***
	(0.0133)	(0.0172)	(0.0213)	(0.0215)	(0.0307)	(0.0127)	(0.0187)
2015.year	0.0565***	0.0560***	0.0589***	0.158***	0.0363	0.0579***	0.134***
	(0.0181)	(0.0178)	(0.0208)	(0.0210)	(0.0253)	(0.0141)	(0.0186)
2016.year	0.0780***	0.0682***	0.0445**	0.133***	0.0557**	0.0750***	0.113***
	(0.0173)	(0.0191)	(0.0206)	(0.0181)	(0.0273)	(0.0142)	(0.0152)
2017.year	0.0871***	0.0633***	0.0891***	0.162***	0.0481*	0.0714***	0.148***
	(0.0185)	(0.0175)	(0.0215)	(0.0245)	(0.0289)	(0.0132)	(0.0217)
2018.year	0.0908***	0.0814***	0.0828***	0.204***	0.0616*	0.0837***	0.175***
	(0.0202)	(0.0178)	(0.0214)	(0.0254)	(0.0323)	(0.0148)	(0.0215)
2019.year	0.111***	0.115***	0.0783***	0.214***	0.0850***	0.118***	0.176***
	(0.0189)	(0.0191)	(0.0211)	(0.0259)	(0.0323)	(0.0157)	(0.0220)
2020.year	0.144***	0.147***	0.108***	0.261***	0.116***	0.148***	0.219***
	(0.0182)	(0.0195)	(0.0269)	(0.0279)	(0.0314)	(0.0154)	(0.0245)
2021.year	0.171***	0.187***	0.151***	0.329***	0.203***	0.188***	0.286***
	(0.0312)	(0.0187)	(0.0287)	(0.0260)	(0.0324)	(0.0189)	(0.0236)
omitted.treatment	-	-	-	-	-	-	-
treatment × after	0.0665***	0.0719***	0.126***	0.0365***	0.0388***	0.0793***	0.0661***
	(0.0149)	(0.0123)	(0.0199)	(0.0138)	(0.00959)	(0.00952)	(0.0125)
finnoo		-0.191***	-0.140***	-0.00662	-0.0137*	-0.199***	-0.0323**
		(0.0232)	(0.0297)	(0.0151)	(0.00787)	(0.0188)	(0.0136)
kauklahti		-0.225***	-0.286***	-0.0944*		-0.215***	-0.174***
		(0.0240)	(0.0608)	(0.0497)		(0.0223)	(0.0383)

excellent		0.228***				0.158**	
		(0.0661)				(0.0707)	
omitted.kaitaa			-	-	-		-
Kera			-0.162***	-0.118***	-0.153***		-0.121***
			(0.0327)	(0.0123)	(0.00722)		(0.00992)
omitted.soukka				-	-		
omitted.esp. lahti				-	-		
Constant	-16.43***	-16.49***	-12.58***	-6.088***	-13.93***	-18.09***	-8.076***
	(0.879)	(1.044)	(1.695)	(1.085)	(0.750)	(0.767)	(1.011)
Observations	2,313	2,330	885	1,803	3,082	4,643	2,688
R-squared	0.755	0.824	0.862	0.839	0.824	0.779	0.832

Notes: Robust standard errors in parentheses.

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table A2. Yearly treatment effects

	0–800 m log price	800–1 600 m log price	1 600–2 000 m log price
2010	-0.00290	-0.0732***	-0.0742***
	(0.0213)	(0.0265)	(0.0214)
2011	-0.0207	-0.0229	-0.0544**
	(0.0181)	(0.0252)	(0.0231)
2012	-0.00845	-0.0132	-0.0384
	(0.0196)	(0.0242)	(0.0238)
2013	-0.0213	0.0347	-0.0360*
	(0.0188)	(0.0254)	(0.0200)
2014 omitted	0	0	0
	(0)	(0)	(0)
2015	0.0190	0.0162	-0.0354
	(0.0193)	(0.0240)	(0.0274)
2016	0.0318*	0.0750**	-0.0115
	(0.0185)	(0.0316)	(0.0243)
2017	0.0985***	0.0553**	0.0725***
	(0.0281)	(0.0274)	(0.0226)
2018	0.0563***	0.0599**	0.00869
	(0.0201)	(0.0274)	(0.0312)
2019	0.111***	0.0508*	-0.00384
	(0.0203)	(0.0280)	(0.0235)
2020	0.0525**	0.0169	-0.00581
	(0.0213)	(0.0405)	(0.0262)
2021	0.128***	0.0711**	-0.0293
	(0.0321)	(0.0318)	(0.0271)
Constant	-18.01***	-7.918***	-14.01***
	(0.781)	(1.016)	(0.788)
Observations	4,643	2,688	3,082
R-squared	0.781	0.833	0.826

Notes: Robust standard errors in parentheses.

*** $p<0.01$, ** $p<0.05$, * $p<0.1$