MUNI ECON

WORKING PAPER

n. 2022-05
ISSN 2571-130X
DOI: 10.5817/WP_MUNI_ECON_2022-05

Expected Transport Accessibility Improvement and House Prices: Evidence from the Construction of the World’s Longest Undersea Road Tunnel

Štěpán Mikula / Masaryk University, Faculty of Economics and Administration
Peter Molnár / University of Stavanger, Prague University of Economics and Business, Nicolaus Copernicus University in Torun

Expected Transport Accessibility Improvement and House Prices: Evidence from the Construction of the World’s Longest Undersea Road Tunnel

Abstract

This paper studies the impact of expected transport accessibility improvement on house prices. We identify the effect exploiting a quasi-natural experiment created by the approval and construction of the Ryfast tunnel system in Rogaland, Norway, which shortened the travelling time to the affected municipality from 62 to 24 minutes. Estimates of a repeated sales model in a difference-indifferences framework show that the expectation of improvement in transport accessibility connected with the construction of the tunnel system led to an increase in house prices by 10.1–12.8average. That effect grew as the opening of the tunnel drew closer and was driven by less valuable houses.

Masaryk University
Faculty of Economics and Administration

Authors:
Štěpán Mikula (ORCID: 0000-0003-1725-8561) / Masaryk University, Faculty of Economics and Administration
Peter Molnár / University of Stavanger, Prague University of Economics and Business, Nicolaus Copernicus University in Torun

Contact: stepan.mikula@econ.muni.cz

Creation date: 2022-03
Revision date: 2023-01

Keywords: transport accessibility; expectations; house prices; Ryfast tunnel system construction; Norway
JEL classification: R3, R4

Citation:
Mikula, Š., Molnár, P. (2022). *Expected Transport Accessibility Improvement and House Prices: Evidence from the Construction of the World’s Longest Undersea Road Tunnel*. MUNI ECON Working Paper n. 2022-05. Brno: Masaryk University. https://doi.org/10.5817/WP_MUNI_ECON_2022-05

MUNI ECON Working Paper n. 2022-05
ISSN 2571-130X

Expected Transport Accessibility Improvement and House Prices: Evidence from the Construction of the World's Longest Undersea Road Tunnel

Štěpán Mikula*[a] and Peter Molnár†[b,c,d]

[a]Masaryk University, Brno, Czech Republic
[b]University of Stavanger, Stavanger, Norway
[c]Prague University of Economics and Business, Prague, Czech Republic
[d]Nicolaus Copernicus University in Torun, Torun, Poland.

March 9, 2022

This paper studies the impact of expected transport accessibility improvement on house prices. We identify the effect exploiting a quasi-natural experiment created by the approval and construction of the Ryfast tunnel system in Rogaland, Norway, which shortened the travelling time to the affected municipality from 62 to 24 minutes. Estimates of a repeated sales model in a difference-in-differences framework show that the expectation of improvement in transport accessibility connected with the construction of the tunnel system led to an increase in house prices by 10.1–12.8% on average. That effect grew as the opening of the tunnel drew closer and was driven by less valuable houses.

Keywords: transport accessibility; expectations; house prices; Ryfast tunnel system construction; Norway
JEL Codes: R3, R4
Declarations of interest: None.

*Corresponding author. Address: Masaryk University, Lipová 41a, 60200 Brno, Czech Republic. Email: stepan.mikula@econ.muni.cz. Mikula acknowledges financial support as part of a joint grant from the Czech Science Foundation and Austrian Science Fund (GF20-18033L).
†Email: peto.molnar@gmail.com

1 Introduction

Transport accessibility is important for individuals and businesses alike. Transport accessibility improvements have a wide range of consequences, which include regional development acceleration and unemployment reduction (Rokicki and Stępniak 2018). It takes a long time for such effects to manifest themselves. By contrast, house prices are able to accommodate such improvements more rapidly. People prefer to live in locations with better access to amenities. Since amenities are usually concentrated in city centres, locations are more valuable when they have better transportation accessibility to city centres. Yang et al. (2019) and Yang et al. (2020) find that access to bus stops and access by bus to important amenities significantly influence housing prices. Similar conclusions have been reached in relation to railway accessibility in Hong Kong (He 2020) and China (Liu et al. 2021). However, not all studies have found that transport accessibility has a positive impact on house prices. Andersson et al. (2010) conclude that a high-speed railway line connecting seven metropolitan areas in Taiwan has at most a small effect on house prices.

Identification of the effect of improved accessibility on house prices typically exploits various infrastructure changes. For instance, the opening of a subway system in Taipei (Lin and Hwang 2004), a subway system expansion in Beijing (Sun et al. 2015), new rail stations in London (Gibbons and Machin 2005), light rail transit in Charlotte, North Carolina (Billings 2011), upgraded road width and quality in India (Ghani et al. 2013), a new commuter train service between a major city (Montreal, Canada) and its periphery (Dubé et al. 2013), a new tunnel in the Netherlands (Hoogendoorn et al. 2019) or new rail lines in Hong Kong (He 2020). Most of these studies have found that improved transport accessibility has a positive impact on house prices.

However, identifying the true effect is challenging, since accessibility changes are often related to large and expensive infrastructural projects and are therefore likely to be anticipated. This means that peoples' expectations of improved accessibility could be incorporated into house prices before the transport change actually takes place. If so, identification exploiting the actual change in accessibility would underestimate the effect of the improvement in transport accessibility. This is where our paper's contribution lies. We estimate the effect of expected improvement in transport accessibility on house prices, focusing on the period before the opening of the Ryfast tunnel system in Norway, which shortened travel time to the affected municipality from 62 to 24 minutes.

Residents must have expected the improvement in transport accessibility brought by the opening of the tunnel system from at least the time when construction of the Ryfast tunnel was first approved. We identify the effect of that expected improvement in transport accessibility by examining the prices of houses that were sold before as well as after the approval of the Ryfast construction. The effect is estimated using a repeated sales model in a difference-in-differences framework, using house sales in an unaffected municipality as a control group.

The existing papers most closely related to ours are Hoogendoorn et al. (2019) and Bao et al. (2021), which study the construction and opening of tunnels in the Netherlands and Hong Kong respectively. Hoogendoorn et al. (2019) find support for the idea of anticipation: about half of the accessibility effect already materializes more than one year before the opening of the tunnel. Similarly, Bao et al. (2021) identify a significant accessibility premium well before the tunnel is completed.

The Ryfast tunnel construction created a setup that is particularly suitable for an identification of the effect of expected transport improvement for multiple reasons: (a) the Ryfast tunnel system was a large infrastructure project that substantially decreased travel times; (b) its construction took nearly eight years, which enables us to study the dynamics of the treatment effect as the opening approached; (c) in contrast to the cases studied by Hoogendoorn et al. (2019) and Bao et al. (2021) the topology of the region enables us to specify a control group of residents directly unaffected by the Ryfast tunnel; (d) last but not least, the Norwegian property market is highly liquid and properties are usually sold in auctions which ensures the prices closely reflect the market value.

In our paper we find support for the expectation hypothesis, as the approval of construction plans for the Ryfast tunnel increased house prices in the affected municipality by 10.1–12.8% on average, even before the tunnel had opened. We find that this effect became stronger as the tunnel opening approached, with no significant effect in the four years immediately following the approval of the plans in 2012. The significant and substantial effect of over 20% is concentrated in the last four years prior to the opening of the tunnel, which took place in early 2020. Moreover, we find that the effect is heterogeneous in house value: lower priced houses appreciated by 19.1–23.6%, medium priced housed appreciated by 12.2–13.6%, while the value of high priced houses did not increase.

The rest of this paper is organized as follows. Section 2 describes the Ryfast tunnel system and its history. Section 3 presents the identification strategy, empirical specification and data. Section 4 discusses the results. Section 5 concludes.

2 The Ryfast tunnel system

The population in Rogaland county, West Norway, is concentrated in the Stavanger municipal area[1]; 54% (233,964) of the county's population lived in this area in 2011 (see Figure 1).[2] Stavanger is the only major city in the region; the next nearest major cities, Bergen and Kristiansand, are both more than 160 km away. Norway's rugged coast and rough terrain make some *kommuner* (municipalities) hard to access from Stavanger. Strand *kommune* with a population of 11,379 concentrated in the towns of Jørpeland and Tau[3], is an excellent example of this: despite being located only about 13 kilometres away from Stavanger, across the fjord, the driving time from Stavanger to Strand was about one hour (see Figure 2).

The idea of building a faster permanent connection between Stavanger and Strand arose in the 1970s and was discussed for several decades. After a proposal from the county council for the construction of a submerged floating tunnel failed to obtain support from the government in 1998, a new plan for the Ryfast undersea tunnel system was developed. The Ryfast tunnel system consists of three tunnels: Ryfylketunnelen, Eiganestunnelen, and Hundvågtunnelen. The project was approved by the Storting (Norwegian parliament) on June 12th 2012 by a vast majority: 77 votes in favour and 22 against. However, support for the proposal was lower among Storting representatives from Rogaland, of whom five voted in favour and four against.[4]

Construction of the tunnel system commenced in 2013 and the tunnel opened for public transport in December 2019 and for general public use in April 2020. With its total length of 14.5 kilometres and depth of 390 metres, the Ryfast tunnel is the longest and deepest undersea road tunnel in the world.

3 Identification strategy and empirical specification

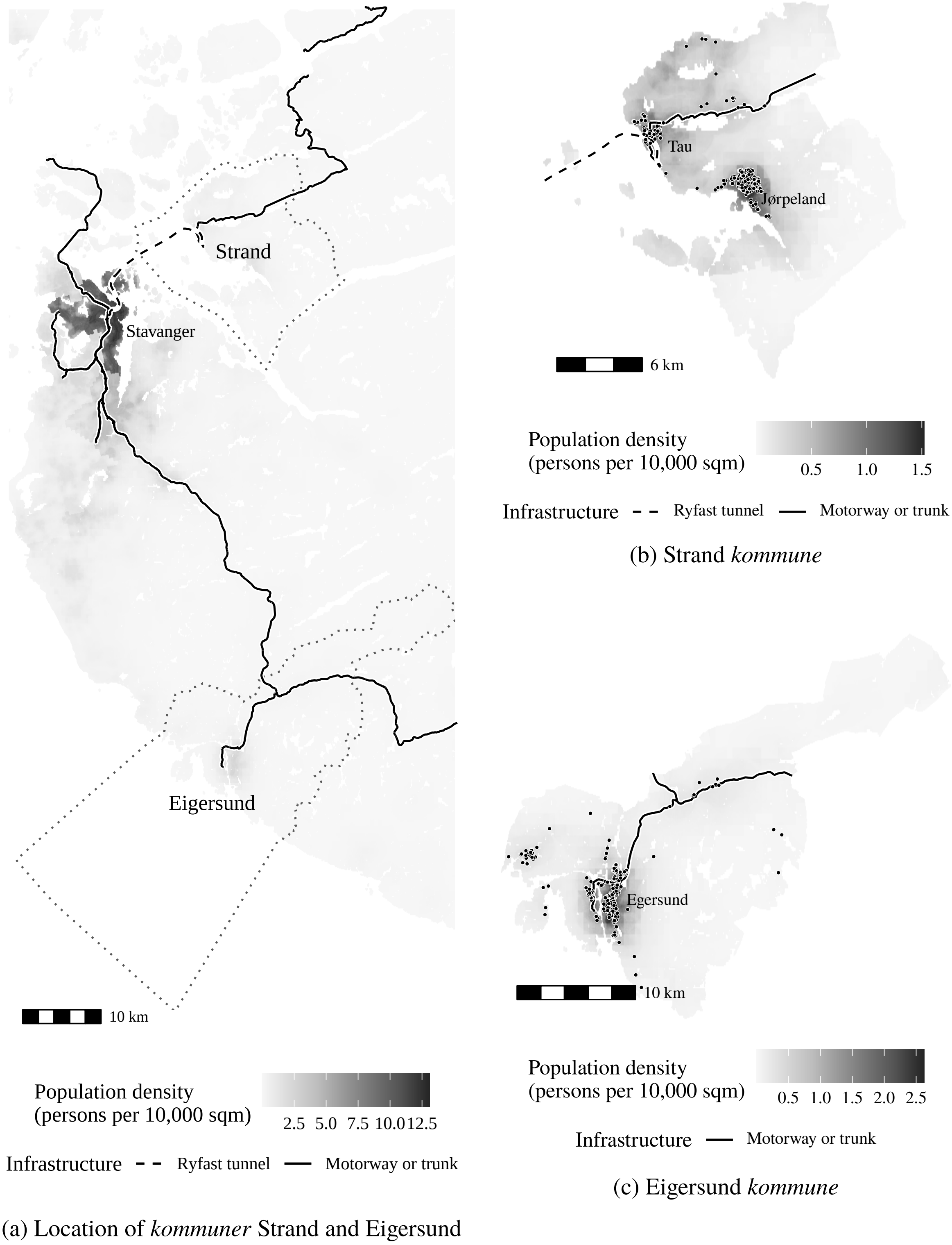
The opening of the Ryfast tunnel system decreased the driving time from Stavanger to Strand substantially, by 62% on average, i.e. from 62.4 to 23.7 minutes (see Figure 2). This improvement in transport accessibility was expected some time before the tunnel system actually opened and could therefore be accommodated into house prices before it had any real impact on transport time. Strand *kommune* is remote and sparsely populated, and the

1. Rogaland county (*fylke*) consists of 23 municipalities (*kommuner*). We define the Stavanger municipal area as *kommuner* Stavanger, Sola, Sandnes, and Randaberg.

2. For population statistics at county and municipal levels see table 05212 at Statistics Norway: https://www.ssb.no/en/statbank/table/05212 (last accessed on November 23rd 2021).

3. *Kommuner* may contain one or more towns of similar size.

4. For detail see the Storting website: https://www.stortinget.no/no/Saker-og-publikasjoner/Saker/Sak/?p=53758 (last accessed on November 29th 2021).



(a) Location of *kommuner* Strand and Eigersund

(b) Strand *kommune*

(c) Eigersund *kommune*

Figure 1: *Kommuner* Strand and Eigersund in Rogaland *fylke*

Note: The points in panels (b) and (c) indicate the locations of the houses included in the estimation sample.
Sources: MAP Project (estimated 2011 population density), OSM (infrastructure).

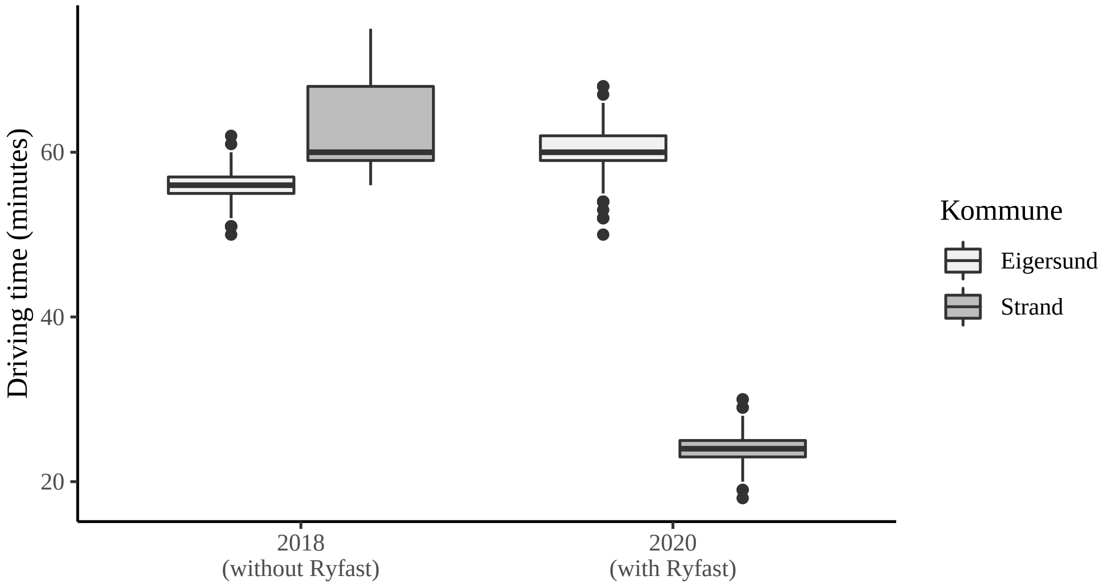


Figure 2: Driving time to Stavanger before and after Ryfast opening

Note: Driving times between houses in our estimation sample (see Section 3.1) and Stavanger city centre (coordinates 58.967114, 5.732246) are calculated using Routino navigation software and Open Street Map data from 2018 and 2020. For details see Section 3.1.

Ryfast tunnel system was thus unlikely to have any substantial effect on other *kommuner* in Rogaland.

This geographical setup allows us to identify the effect of an expected improvement in transport accessibility in difference-in-differences (DiD) framework for which we use houses from the unaffected Eigersund *kommune* as a control group. The Eigersund *kommune* is located southeast of Stavanger, i.e. approximately in the opposite direction compared to Strand (see Figure 1). Its population size is similar to that of Strand (14,346 as of 2011, i.e. 21% larger than Strand) as is its driving time to Stavanger (56.0 minutes, i.e. 12% shorter than Strand prior to the Ryfast tunnel system; see Figure 2). House prices were slightly higher in Strand throughout the observation period but the gap between prices in Strand and Eigersund remained stable until 2014, i.e. two years after the construction of the Ryfast tunnel system was approved (see Appendix Figure A.1).[5] On the other hand there were 56% more house sales in Eigersund *kommune* and this gap remained stable throughout the observation period (see Figure A.2 in the Appendix).

House prices could be driven by house and neighbourhood characteristics (such as the proximity of natural or man-made amenities) that are unobservable to us. Therefore, we use a repeated sales model in which we only use price data for houses that were sold both before and after the Ryfast construction was approved. This enables us to take into account

5. For the parallel trends assumption test conducted on the estimation sample see Section B in the Appendix.

the impact of all house-specific time-invariant characteristics. As house prices may also be affected by unobserved factors common to houses in a particular area, we estimate the effect of expected improvement in transport accessibility in a spatial error model (SEM):

$$\log(P_{i,t_1}) - \log(P_{i,t_0}) = \alpha + \gamma S_i + \kappa \log\left(P^{sqm}_{i,t_0}\right) + \delta T_i + \sum_j \beta_j \mathbf{y}_{i,j} + \varepsilon_i \quad (1)$$

$$\varepsilon_i = \lambda \mathbf{W} \varepsilon_i + u_i \quad (2)$$

where the dependent variable is the difference in logarithms between the price of house i when sold after (t_1) and before (t_0) the Ryfast construction approval, the effect of which is identified by coefficient γ for an indicator variable S which is equal to one for houses in Strand *kommune*. Other explanatory variables capture the initial price per square metre (P^{sqm}), the number of years between the first and second sales (T), and year fixed effects for all the years between the two sales ($\mathbf{y}$).

The spatial autocorrelation error term ε is modelled in Equation (2), where u is a well-behaved error term and $\mathbf{W}$ is a row standardized spatial contiguity weight matrix with individual weights defined as:

$$W[i_a, i_b] = \begin{cases} 1/d & \text{if } d \leq 10 \\ 0 & \text{otherwise} \end{cases}$$

where d is the driving time between houses i_a and i_b in minutes. Results obtained with alternative specifications of the weight matrix are presented in Section 4.1. The system of Equations (1) and (2) is estimated using the maximum likelihood procedure, implemented in *spatialreg* package in R.

3.1 Data and estimation sample

The primary data set used in our analysis is a database of individual records on property sales in Rogaland county, West Norway, collected and provided by the Alva Technologies consultancy. The data set contains a property ID, geographic location (longitude and latitude), house price, and sale date for each sale. It further contains basic house characteristics, such as the floor area and number of rooms, bathrooms, and floors. These are, however, time invariant and do not allow us to control for changes in house characteristics in Equation (1).

We augment this primary data set with driving times between house pairs and to Stavanger city centre.[6] The driving times are calculated using Open Street Map (OSM) data[7] and Routino navigation software in version 3.3.2.

To obtain our estimation sample, we limit the data set to houses in Strand (treated group) and Eigersund (control group) *kommuner* that were sold at least once before (during the pre-treatment period, 2005–June 12$^{\text{th}}$ 2012) and once after (during the post-treatment period, June 12$^{\text{th}}$ 2012–2019) construction of the Ryfast tunnel system was approved.[8] The observation period is restricted to the 7.5 years that passed between the date on which construction of the tunnel system was approved and the date on which it opened and the same amount of time prior to the date of approval. We exclude 4 houses from the estimation sample due to missing house characteristics and another 8 houses that had the highest yearly price growth (over 202.1%, i.e. the top one percent) which is likely to be driven by coding errors or substantial reconstructions unobservable in our data (for the distribution of average annual growth rates see Appendix Figure A.3). The resulting estimation sample contains 721 houses (i.e. 12.7% of all houses sold in the period[9]): 305 (42%) from Strand, and 416 (58%) from Eigersund. The proportions of houses in the estimation sample correspond neatly to the proportions in the full sample of property sales, which contains 56% property sales in Eigersund and 44% in Strand (see also Appendix Figure A.2).

The houses in our estimation sample are concentrated in the towns of Tau and Jørpeland within Strand *kommune*, and in the town of Egersund within Eigersund *kommune* (see panels (b) and (c) in Figure 1).[10] Property prices were comparable in both *kommuner* in the pre-treatment period, but grew 32% faster in Strand *kommune* than in Eigersund *kommune* between the periods. The average time between the first and second sales was 6 years in Eigersund and 2.7 months less in Strand.

6. We use the location of the main train station in Stavanger (coordinates 58.967114, 5.732246) as the city centre reference point.

7. We use two different OSM extracts to calculate the driving times. The extract for June 30$^{\text{th}}$ 2018 is used to calculate driving times before the Ryfast tunnel system opened, and the extract from August 24$^{\text{th}}$ 2020 (from https://www.geofabrik.de/) is used to calculate driving times after the Ryfast tunnel system opened.

8. When a given house was sold multiple times during the pre- or post-treatment period we consider the sale closest to the date on which construction of the Ryfast tunnel system was approved.

9. Houses included in our estimation sample tend to be more expensive. A descriptive regression $\log(P_i^{sqm}) = \alpha + \nu E_i + \theta_i + \omega$, where E_i is an indicator variable for inclusion in the estimation sample, θ_i is year fixed effect, ω is an error term and the rest of the notation follows Equation (1), estimated separately for both *kommuner* on houses sold in the pre-treatment period, shows that the houses included in our estimation sample were 12.7% more expensive than the average house in Eigersund and 19.4% more expensive than the average house in Strand.

10. The high geographical concentration of the houses in our estimation sample results in low variation in the driving times from these houses to Stavanger (see Figure 2).

4 Results

The estimates of our baseline specification, reported in Table 1, show that the approval of plans for the Ryfast tunnel system increased house prices in Strand *kommune* by between 10.1% and 12.8%. The effect is slightly larger in the model specifications reported in columns (3) and (4), which control for year fixed effects. The statistically significant (at 10% level) estimates of the spatial error parameter λ in columns (1) and (2) ex post justify the use of the SEM model.

Table 1: The effect of expected improvement in transport accessibility on house prices

	Dependent variable: Difference in house price logarithms			
	(1)	(2)	(3)	(4)
Strand kommune (= 1)	0.101***	0.114***	0.126***	0.128***
	(0.029)	(0.028)	(0.028)	(0.028)
Price per sqm (log, first sale)	−0.576***	−0.543***	−0.521***	−0.521***
	(0.025)	(0.025)	(0.025)	(0.025)
Time between first and second sale (years)		0.039***		0.021
		(0.006)		(0.039)
Intercept	5.715***	5.176***	4.878***	4.869***
	(0.234)	(0.239)	(0.243)	(0.243)
Spatial error parameter (λ)	−0.628*	−0.659*	−0.576	−0.578
	(0.353)	(0.345)	(0.366)	(0.366)
Year fixed effects			Yes	Yes
Observations (n)	721	721	721	721

Notes: The table reports coefficients from Equations (1) and (2). Standard errors are reported in parentheses: *, ** and *** denote statistical significance at 10%, 5% and 1%.

Additionally, we augment Equation (1) to explore treatment effect heterogeneity in the house value and the time of the sale within the treated period.

First, we extend the specification with the full interaction of the variable of interest, i.e. indicator variable for Strand *kommune*, with house value category and category fixed effects. We classify houses into three house value categories (low, medium, high) using their prices in the pre-treatment period. Categories are defined as tertiles and are calculated separately for each *kommune* and year. The results reported in Table 2 show that the total effect in our baseline estimates is driven by cheaper houses. The Ryfast tunnel system go-ahead had the strongest effect on the prices of the cheapest houses, where it led to price growth of between 19.1% and 23.6%; houses in the medium price category underwent price growth of between 12.2% and 13.6%. The effect on house prices in the highest price category was negligible and statistically insignificant.

Table 2: Heterogeneity in treatment effect by house value

	Dependent variable: Difference in house price logarithms			
	(1)	(2)	(3)	(4)
Strand *kommune*, low price category (= 1)	0.191***	0.205***	0.235***	0.236***
	(0.052)	(0.050)	(0.049)	(0.049)
Strand *kommune*, medium price category (= 1)	0.122**	0.124**	0.133**	0.136***
	(0.055)	(0.053)	(0.052)	(0.052)
Strand *kommune*, high price category (= 1)	−0.018	−0.001	0.007	0.008
	(0.053)	(0.051)	(0.051)	(0.051)
Price per sqm (log, first sale)	−0.531***	−0.483***	−0.453***	−0.453***
	(0.029)	(0.029)	(0.029)	(0.029)
Time between first and second sale (years)		0.041***		0.025
		(0.006)		(0.039)
Intercept	5.334***	4.660***	4.282***	4.271***
	(0.260)	(0.266)	(0.268)	(0.269)
Spatial error parameter (λ)	−0.526	−0.532	−0.323	−0.325
	(0.378)	(0.377)	(0.411)	(0.411)
Price quantile fixed effects	Yes	Yes	Yes	Yes
Year fixed effects			Yes	Yes
Observations (n)	721	721	721	721

Notes: The table reports coefficients from modified Equations (1) and (2). Standard errors are reported in parentheses: *, ** and *** denote statistical significance at 10%, 5% and 1%. The categories are defined as pre-treatment house price tertiles calculated separately for each *kommune* and year.

Secondly, we fully interact the indicator variable for Strand *kommune* with the time of sale in the treated period. Due to our limited number of observations, we aggregate years of sale into four two-year categories, i.e. 2012–2013, 2014–2015, 2016–2017, 2018–2019. The modified specification also includes time of sale fixed effects.[11] The results reported in Table 3 show that the effect increased as the opening of the Ryfast tunnel system approached, and that there was no significant effect in the four years that immediately followed on from the approval of the construction plans. The significant and substantial effect on house prices (over 20% in all cases) is concentrated in the last four years before the tunnel opened (i.e. time periods 2016–2017 and 2018–2019).

11. Including time of sale fixed effects leads to perfect collinearity with some year fixed effects in Equation (1). In such cases, perfectly collinear fixed effects are excluded.

Table 3: Heterogeneity in treatment effect by time of sale

	Dependent variable: Difference in house price logarithms			
	(1)	(2)	(3)	(4)
Strand *kommune*, sold in 2012 or 2013 (= 1)	0.009	0.028	0.028	0.030
	(0.052)	(0.050)	(0.050)	(0.050)
Strand *kommune*, sold in 2014 or 2015 (= 1)	0.069	0.078	0.085	0.085
	(0.058)	(0.055)	(0.055)	(0.055)
Strand *kommune*, sold in 2016 or 2017 (= 1)	0.208***	0.222***	0.215***	0.218***
	(0.069)	(0.066)	(0.066)	(0.066)
Strand *kommune*, sold in 2018 or 2019 (= 1)	0.220***	0.249***	0.268***	0.267***
	(0.074)	(0.070)	(0.070)	(0.070)
Price per sqm (log, first sale)	−0.573***	−0.521***	−0.520***	−0.520***
	(0.025)	(0.025)	(0.025)	(0.025)
Time between first and second sale (years)		0.066***		0.021
		(0.007)		(0.035)
Intercept	5.652***	4.546***	4.808***	4.726***
	(0.237)	(0.258)	(0.265)	(0.299)
Spatial error parameter (λ)	−0.656*	−0.644*	−0.636*	−0.633*
	(0.346)	(0.349)	(0.351)	(0.352)
Time of sale fixed effects	Yes	Yes	Yes	Yes
Year fixed effects			Yes	Yes
Observations (n)	721	721	721	721

Notes: The table reports coefficients from modified Equations (1) and (2). Standard errors are reported in parentheses: *, ** and *** denote statistical significance at 10%, 5% and 1%.

4.1 Robustness checks and placebo tests

The baseline specification models spatial auto-correlation in the error term using a weight matrix that levels off the weights to zero at a driving time greater than 10 minutes. In an alternative specification we (a) shift the threshold to 20 minutes, and (b) set equal weights to all houses within 10 minutes driving time of each other. The results, which are reported in Appendix Table A.1, do not substantially deviate from our baseline estimates.

As an alternative to the Spatial Error Model (SEM) we estimate Equation (1) by OLS with Conley standard errors, using distance cutoffs at 5, 10, and 15 kilometres. While SEM works with driving times, the Conley standard errors use euclidean distance. This makes the use of Conley standard errors problematic in regions with rugged coastlines, which is the case especially in Eigersund *kommune*. The estimated coefficients, reported in Appendix Table A.2, are slightly larger (13.2% to 14.8%) than our baseline estimates but retain statistical significance for all cutoffs.

Additionally, we conduct a falsification placebo test using house sales from the period before the plans for the Ryfast tunnel system were approved (i.e. 2005–June 12th 2012). To do so, we artificially shift the approval date to December 31st 2009 and re-estimate Equations (1) and (2). The results, reported in Appendix Table A.3, show that the coefficients of interest are insignificant and close to zero (between −2.4 and 2.6%), i.e. approximately four to five times lower in magnitude than those found when using the real approval date.

5 Conclusions

In this paper, we study the impact of an expected improvement in transport accessibility on house prices by exploiting the construction of the Ryfast tunnel system in Norway. This tunnel shortened the travel time between one affected *kommune* (municipality) and the nearest city from 62 minutes to 24 minutes, while it did not affect other *kommuner* (municipalities). This setup enables us to use a difference-in-difference estimator in a repeated sales model.

We find that the expectation of a substantial improvement in travel accessibility has a positive impact on house prices, raising them by between 10.1% and 12.8% in the affected *kommune* during the period between the tunnel plans receiving approval and the tunnel opening to traffic. Eight years passed between the approval of the construction plans and the tunnel actually opening. For the first four of those years we do not observe any significant effect on house prices. However, during the subsequent four years (i.e. the four years immediately preceding the opening of the tunnel), house prices in the affected municipality increased by more than 20%. Interestingly, this price increase was primarily driven by low-priced houses (in terms of price per square metre). Low-priced houses appreciated by

19.1–23.6%, medium-priced houses appreciated by 12.2–13.6%, while high-priced houses did not experience any price appreciation.

This study illustrates how important it is to take expectations into account when evaluating transport infrastructure improvements. Overlooking house price increases that take place before the new infrastructure is in operation could lead to underestimating the overall impact of the improved accessibility and to incorrect conclusions.

Moreover, if improved transport infrastructure primarily benefits poorer people, then infrastructure improvements could serve as a policy tool. We believe that this topic should be investigated in greater detail and we recommend it as an avenue for further research.

References

Andersson, David Emanuel, Oliver F Shyr, and Johnson Fu. 2010. "Does high-speed rail accessibility influence residential property prices? Hedonic estimates from southern Taiwan." *Journal of Transport Geography* 18 (1): 166–174.

Bao, Helen XH, Johan P Larsson, and Vivien Wong. 2021. "Light at the end of the tunnel: The impacts of expected major transport improvements on residential property prices." *Urban Studies* 58 (14): 2971–2990.

Billings, Stephen B. 2011. "Estimating the value of a new transit option." *Regional Science and Urban Economics* 41 (6): 525–536.

Dubé, Jean, Marius Thériault, and Francois Des Rosiers. 2013. "Commuter rail accessibility and house values: The case of the Montreal South Shore, Canada, 1992–2009." *Transportation Research Part A: Policy and Practice* 54:49–66.

Ghani, Syed Ejaz, Arti Grover Goswami, and William Kerr. 2013. "Highway to success in India: the impact of the golden quadrilateral project for the location and performance of manufacturing." *World Bank Policy Research Working Paper,* no. 6320.

Gibbons, Stephen, and Stephen Machin. 2005. "Valuing rail access using transport innovations." *Journal of urban Economics* 57 (1): 148–169.

He, Sylvia Y. 2020. "Regional impact of rail network accessibility on residential property price: Modelling spatial heterogeneous capitalisation effects in Hong Kong." *Transportation Research Part A: Policy and Practice* 135:244–263.

Hoogendoorn, Sander, Joost van Gemeren, Paul Verstraten, and Kees Folmer. 2019. "House prices and accessibility: evidence from a quasi-experiment in transport infrastructure." *Journal of economic geography* 19 (1): 57–87.

Lin, Jen-Jia, and Chi-Hau Hwang. 2004. "Analysis of property prices before and after the opening of the Taipei subway system." *The Annals of Regional Science* 38 (4): 687–704.

Liu, Xueli, Chunxia Jiang, Feng Wang, and Shujie Yao. 2021. "The impact of high-speed railway on urban housing prices in China: A network accessibility perspective." *Transportation Research Part A: Policy and Practice* 152:84–99.

Rokicki, Bartlomiej, and Marcin Stępniak. 2018. "Major transport infrastructure investment and regional economic development–An accessibility-based approach." *Journal of Transport Geography* 72:36–49.

Sun, Weizeng, Siqi Zheng, and Rui Wang. 2015. "The capitalization of subway access in home value: A repeat-rentals model with supply constraints in Beijing." *Transportation Research Part A: Policy and Practice* 80:104–115.

Yang, Linchuan, KW Chau, WY Szeto, Xu Cui, and Xu Wang. 2020. "Accessibility to transit, by transit, and property prices: Spatially varying relationships." *Transportation Research Part D: Transport and Environment* 85:102387.

Yang, Linchuan, Jiangping Zhou, Oliver F Shyr, et al. 2019. "Does bus accessibility affect property prices?" *Cities* 84:56–65.

A Appendix

A.1 Additional tables and figures

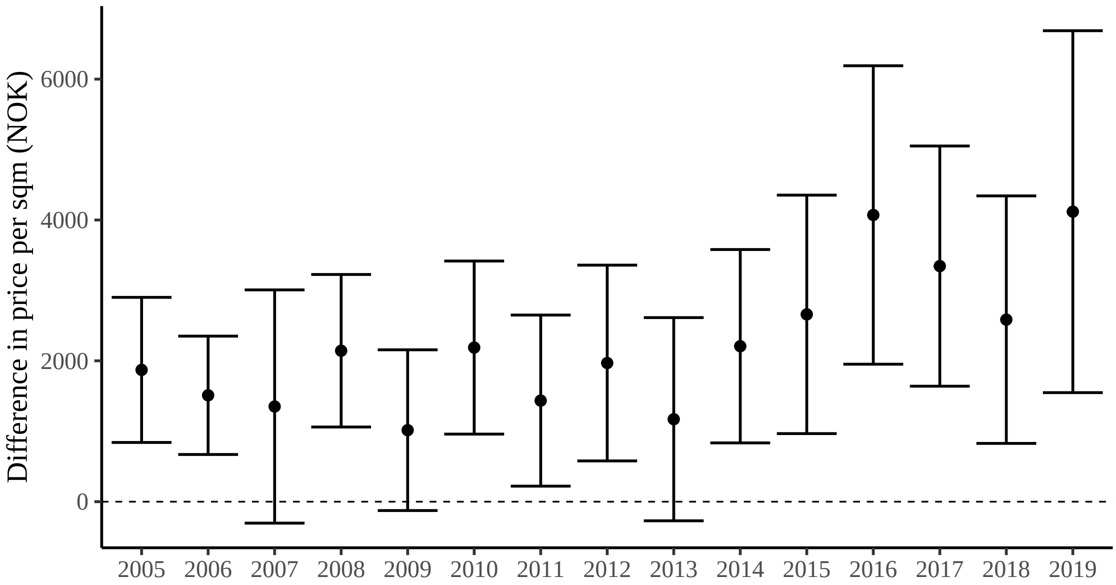


Figure A.1: Price difference between houses sold in Strand and Eigersund

Note: The figure depicts 95% confidence intervals and point estimates of coefficients θ from regression $P_i^{sqm} = \nu + \theta S_i + \omega_i$, where P^{sqm} is the price per square metre of house i, S is an indicator variable for a house in Strand *kommune*, ν is a constant and ω is an error term. The regression is estimated separately for each year.

Table A.1: Robustness check: Alternative definition of the weight matrix

	Dependent variable: Difference in house price logarithms			
	(1)	(2)	(3)	(4)
	Panel A: Continuous weights for driving times below 20 minutes			
Strand kommune (= 1)	0.124***	0.133***	0.147***	0.148***
	(0.043)	(0.040)	(0.032)	(0.032)
Price per sqm (log, first sale)	−0.578***	−0.546***	−0.524***	−0.523***
	(0.025)	(0.025)	(0.025)	(0.025)
Time between first and second sale (years)		0.038***		0.025
		(0.006)		(0.035)
Intercept	5.730***	5.195***	4.882***	4.869***
	(0.236)	(0.241)	(0.244)	(0.244)
Spatial error parameter (λ)	−0.294	−0.256	−0.074	−0.072
	(0.440)	(0.452)	(0.485)	(0.485)
	Panel B: Equal weights within 10 minutes			
Strand kommune (= 1)	0.128*	0.137**	0.147***	0.148***
	(0.067)	(0.060)	(0.049)	(0.048)
Price per sqm (log, first sale)	−0.582***	−0.549***	−0.526***	−0.525***
	(0.025)	(0.025)	(0.025)	(0.025)
Time between first and second sale (years)		0.038***		0.023
		(0.006)		(0.035)
Intercept	5.753***	5.225***	4.915***	4.902***
	(0.236)	(0.241)	(0.244)	(0.245)
Spatial error parameter (λ)	0.529***	0.491**	0.386*	0.380
	(0.186)	(0.198)	(0.232)	(0.234)
Year fixed effects			Yes	Yes
Observations (n)	721	721	721	721

Notes: The table reports coefficients from modified Equations (1) and (2). Standard errors are reported in parentheses: *, ** and *** denote statistical significance at 10%, 5% and 1%.

Table A.2: Robustness check: OLS estimates with Conley standard errors

	Dependent variable: Difference in house price logarithms			
	(1)	(2)	(3)	(4)
	Panel A: Cutoff at 5 km			
Strand kommune (= 1)	0.132**	0.136**	0.147***	0.148***
	(0.061)	(0.057)	(0.050)	(0.051)
Price per sqm (log, first sale)	−0.578***	−0.546***	−0.523***	−0.523***
	(0.079)	(0.077)	(0.081)	(0.082)
Time between first and second sale (years)		0.038***		0.020
		(0.008)		(0.053)
Intercept	5.725***	5.194***	4.875***	4.867***
	(0.738)	(0.744)	(0.816)	(0.809)
	Panel B: Cutoff at 10 km			
Strand kommune (= 1)	0.132**	0.136***	0.147***	0.1482***
	(0.052)	(0.049)	(0.044)	(0.045)
Price per sqm (log, first sale)	−0.578***	−0.546***	−0.523***	−0.5231***
	(0.075)	(0.073)	(0.079)	(0.080)
Time between first and second sale (years)		0.038***		0.0202
		(0.008)		(0.055)
Intercept	5.725***	5.194***	4.875***	4.8673***
	(0.695)	(0.686)	(0.776)	(0.767)
	Panel C: Cutoff at 15 km			
Strand kommune (= 1)	0.132***	0.136***	0.147***	0.148***
	(0.043)	(0.041)	(0.036)	(0.037)
Price per sqm (log, first sale)	−0.578***	−0.546***	−0.523***	−0.523***
	(0.068)	(0.067)	(0.075)	(0.076)
Time between first and second sale (years)		0.038***		0.020
		(0.007)		(0.057)
Intercept	5.725***	5.194***	4.875***	4.867***
	(0.637)	(0.621)	(0.729)	(0.718)
Year fixed effects			Yes	Yes
Observations (*n*)	721	721	721	721

Notes: The table reports coefficients from Equation (1) estimated by OLS. Conley standard errors are reported in parentheses: *, ** and *** denote statistical significance at 10%, 5% and 1%.

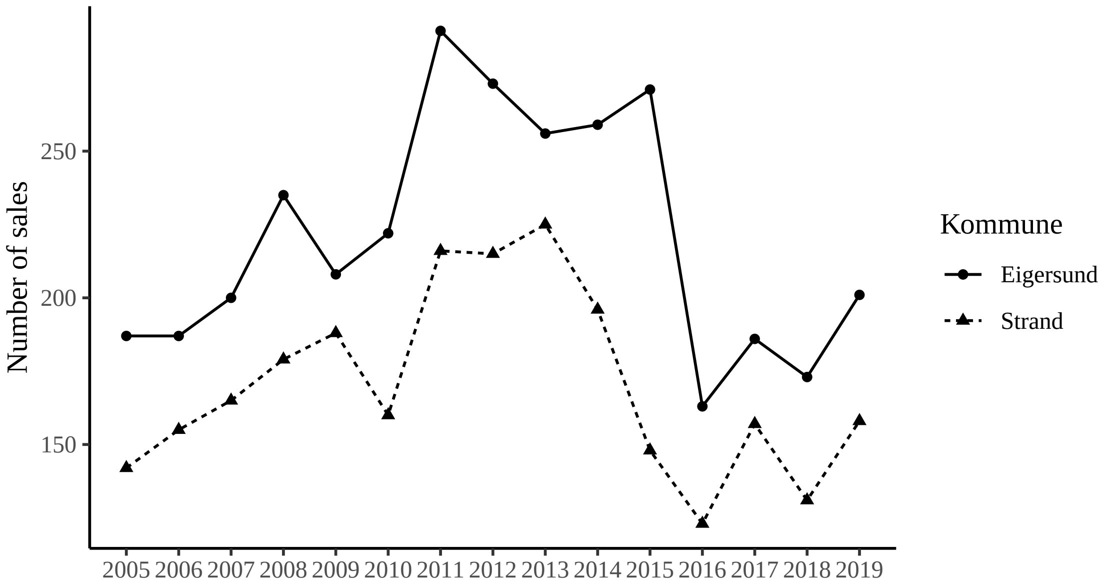


Figure A.2: Number of houses sold in Strand and Eigersund

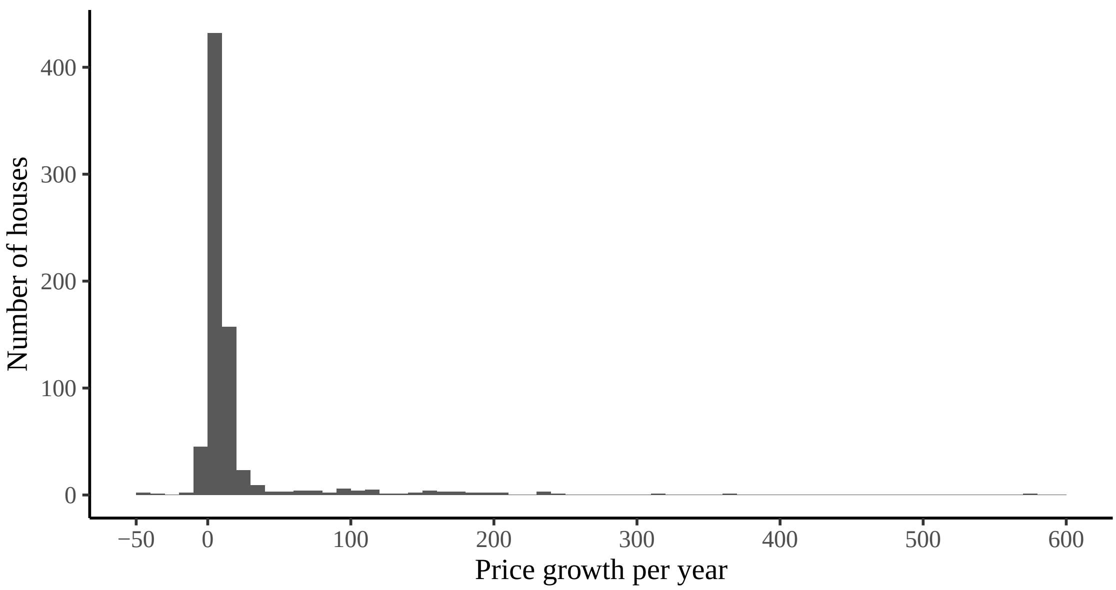


Figure A.3: Average annual growth rate in house prices

Note: Houses with average annual growth rates greater than 202.1% are excluded from the estimation sample.

Table A.3: Placebo

	Dependent variable: Difference in house price logarithms			
	(1)	(2)	(3)	(4)
Strand kommune (= 1)	−0.024	0.006	0.016	0.026
	(0.043)	(0.037)	(0.037)	(0.036)
Price per sqm (log, first sale)	−0.348***	−0.249***	−0.242***	−0.232***
	(0.036)	(0.033)	(0.032)	(0.032)
Time between first		0.128***		0.131***
and second sale (years)		(0.014)		(0.046)
Intercept	3.528***	2.187***	2.371***	2.138***
	(0.325)	(0.313)	(0.300)	(0.307)
Spatial error parameter (λ)	−0.203	−0.279	−0.178	−0.327
	(0.396)	(0.389)	(0.398)	(0.382)
Year fixed effects			Yes	Yes
Observations (n)	254	254	254	254

Notes: The table reports coefficients from Equations (1) and (2). Standard errors are reported in parentheses: *, ** and *** denote statistical significance at 10%, 5% and 1%.

B Parallel trends in the pre-treatment period

The difference-in-differences framework used in the main part of the paper assumes the presence of parallel trends in the pre-treatment period. In this part of the paper we test this assumption by estimating the following Spatial Error Model explaining the logarithm of the house price:

$$\log(P_{i,t_0}) = \alpha + \sum_j \gamma_{jt} S_i \theta_t + \theta_i + \beta \mathbf{X}_i + \varepsilon_i \tag{3}$$

$$\varepsilon_i = \lambda \mathbf{W} \varepsilon_i + u_i \tag{4}$$

where an indicator variable for Strand *kommune* (S) is interacted with year fixed effects (θ_t) and the year 2011 is used as a reference. Additionally we control for a vector of house characteristics $\mathbf{X}$ (area, house type, number of bathrooms, number of rooms, number of floors). The rest of the notation is identical to (1) and (2) in the main text. We estimate the model on a sub-sample limited to the pre-treatment period (2005–2011). Point estimates of γ_{jt} with 95% confidence intervals are reported in Figure B.4. The results suggest that the parallel trends assumption holds. Only the estimate of γ for 2010 is significant at 5% level ($p-$value = 0.05).

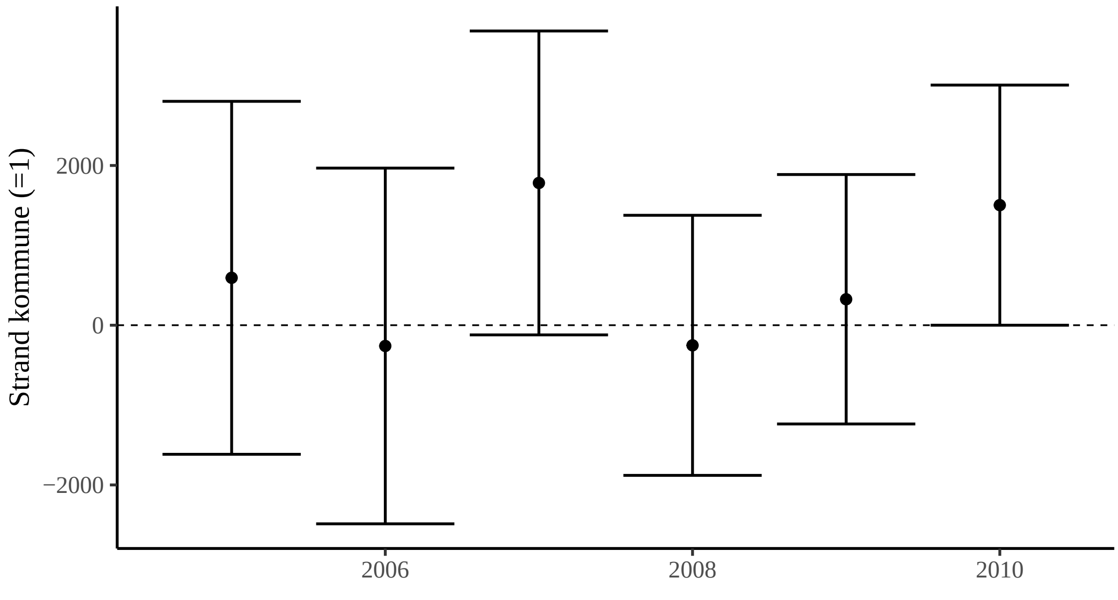


Figure B.4: Parallel trends in pre-treatment period

Notes: The figure reports point estimates and 95% confidence intervals of coefficients γ_{jt} from Equation (3).

MUNI Econ Working Paper Series (since 2018)

2022-05 Mikula, Š., Molnár, P. (2022). *Expected Transport Accessibility Improvement and House Prices: Evidence from the Construction of the World's Longest Undersea Road Tunnel*. MUNI ECON Working Paper n. 2022-05. Brno: Masaryk University. https://doi.org/10.5817/WP_MUNI_ECON_2022-05

2022-04 Coufalová, L., Mikula, Š., Ševčík, M. 2022. *Homophily in Voting Behavior: Evidence from Preferential Voting*. MUNI ECON Working Paper n. 2022-04. Brno: Masaryk University. https://doi.org/10.5817/WP_MUNI_ECON_2022-04

2022-03 Kecskésová, M., Mikula, Š. 2022. *Malaria and Economic Development in the Short-term: Plasmodium falciparum vs Plasmodium vivax*. MUNI ECON Working Paper n. 2022-03. Brno: Masaryk University. https://doi.org/10.5817/WP_MUNI_ECON_2022-03

2022-02 Mladenović, D., Rrustemi, V., Martin, S., Kalia, P., Chawdhary, R. 2022. *Effects of Sociodemographic Variables on Electronic Word of Mouth: Evidence from Emerging Economies*. MUNI ECON Working Paper n. 2022-02. Brno: Masaryk University. https://doi.org/10.5817/WP_MUNI_ECON_2022-02

2022-01 Mikula, Š., Montag, J. 2022. *Roma and Bureaucrats: A Field Experiment in the Czech Republic*. MUNI ECON Working Paper n. 2022-01. Brno: Masaryk University. https://doi.org/10.5817/WP_MUNI_ECON_2022-01

2021-14 Abraham, E. D., Corazzini, L., Fišar, M., Reggiani, T. 2021. *Delegation and Overhead Aversion with Multiple Threshold Public Goods*. MUNI ECON Working Paper n. 2021-14. Brno: Masaryk University. https://doi.org/10.5817/WP_MUNI_ECON_2021-14

2021-13 Corazzini, L., Cotton, C., Longo, E., Reggiani, T. 2021. *The Gates Effect in Public Goods Experiments: How Donations Flow to the Recipients Favored by the Wealthy*. MUNI ECON Working Paper n. 2021-13. Brno: Masaryk University. https://doi.org/10.5817/WP_MUNI_ECON_2021-13

2021-12 Staněk, R., Krčál, O., Mikula, Š. 2021. *Social Capital and Mobility: An Experimental Study*. MUNI ECON Working Paper n. 2021-12. Brno: Masaryk University. https://doi.org/10.5817/WP_MUNI_ECON_2021-12

2021-11 Staněk, R., Krčál, O., Čellárová, K. 2021. *Pull yourself up by your bootstraps: Identifying procedural preferences against helping others in the presence*. MUNI ECON Working Paper n. 2021-11. Brno: Masaryk University. https://doi.org/10.5817/WP_MUNI_ECON_2021-11

2021-10 Levi, E., Sin, I., Stillman, S. 2021. *Understanding the Origins of Populist Political Parties and the Role of External Shocks*. MUNI ECON Working Paper n. 2021-10. Brno: Masaryk University. https://doi.org/10.5817/WP_MUNI_ECON_2021-10

2021-09 Adamus, M., Grežo, M. 202. *Individual Differences in Behavioural Responses to the Financial Threat Posed by the COVID-19 Pandemic*. MUNI ECON Working Paper n. 2021-09. Brno: Masaryk University. https://doi.org/10.5817/WP_MUNI_ECON_2021-09

2021-08 Hargreaves Heap, S. P., Karadimitropoulou, A., Levi, E. 2021. *Narrative based information: is it the facts or their packaging that matters?*. MUNI ECON Working Paper n. 2021-08. Brno: Masaryk University. https://doi.org/10.5817/WP_MUNI_ECON_2021-08

2021-07 Hargreaves Heap, S. P., Levi, E., Ramalingam, A. 2021. *Group identification and giving: in-group love, out-group hate and their crowding out*. MUNI ECON Working Paper n. 2021-07. Brno: Masaryk University. https://doi.org/10.5817/WP_MUNI_ECON_2021-07

2021-06 Medda, T., Pelligra, V., Reggiani, T. 2021. *Lab-Sophistication: Does Repeated Participation in Laboratory Experiments Affect Pro-Social Behaviour?*. MUNI ECON Working Paper n. 2021-06. Brno: Masaryk University. https://doi.org/10.5817/WP_MUNI_ECON_2021-06

2021-05 Guzi, M., Kahanec, M., Ulceluse M., M. 2021. *Europe's migration experience and its effects on economic inequality*. MUNI ECON Working Paper n. 2021-05. Brno: Masaryk University. https://doi.org/10.5817/WP_MUNI_ECON_2021-05

2021-04 Fazio, A., Reggiani, T., Sabatini, F. 2021. *The political cost of lockdown´s enforcement*. MUNI ECON Working Paper n. 2021-04. Brno: Masaryk University. https://doi.org/10.5817/WP_MUNI_ECON_2021-04

2021-03 Peciar, V. *Empirical investigation into market power, markups and employment*. MUNI ECON Working Paper n. 2021-03. Brno: Masaryk University. https://doi.org/10.5817/WP_MUNI_ECON_2021-03

2021-02 Abraham, D., Greiner, B., Stephanides, M. 2021. *On the Internet you can be anyone: An experiment on strategic avatar choice in online marketplaces*. MUNI ECON Working Paper n. 2021-02. Brno: Masaryk University. https://doi.org/10.5817/WP_MUNI_ECON_2021-02

2021-01 Krčál, O., Peer, S., Staněk, R. 2021. *Can time-inconsistent preferences explain hypothetical biases?*. MUNI ECON Working Paper n. 2021-01. Brno: Masaryk University. https://doi.org/10.5817/WP_MUNI_ECON_2021-01

2020-04 Pelligra, V., Reggiani, T., Zizzo, D.J. 2020. *Responding to (Un)Reasonable Requests by an Authority*. MUNI ECON Working Paper n. 2020-04. Brno: Masaryk University. https://doi.org/10.5817/WP_MUNI_ECON_2020-04

2020-03 de Pedraza, P., Guzi, M., Tijdens, K. 2020. *Life Dissatisfaction and Anxiety in COVID-19 pandemic*. MUNI ECON Working Paper n. 2020-03. Brno: Masaryk University. https://doi.org/10.5817/WP_MUNI_ECON_2020-03

2020-02 de Pedraza, P., Guzi, M., Tijdens, K. 2020. *Life Satisfaction of Employees, Labour Market Tightness and Matching Efficiency*. MUNI ECON Working Paper n. 2020-02. Brno: Masaryk University. https://doi.org/10.5817/WP_MUNI_ECON_2020-02

2020-01 Fišar, M., Reggiani, T., Sabatini, F., Špalek, J. 2020. *a*. MUNI ECON Working Paper n. 2020-01. Brno: Masaryk University. https://doi.org/10.5817/WP_MUNI_ECON_2020-01

2019-08 Fišar, M., Krčál, O., Špalek, J., Staněk, R., Tremewan, J. 2019. *A Competitive Audit Selection Mechanism with Incomplete Information*. MUNI ECON Working Paper n. 2019-08. Brno: Masaryk University. https://doi.org/10.5817/WP_MUNI_ECON_2019-08

2019-07 Guzi, M., Huber, P., Mikula, M. 2019. *Old sins cast long shadows: The Long-term impact of the resettlement of the Sudetenland on residential migration*. MUNI ECON Working Paper n. 2019-07. Brno: Masaryk University. https://doi.org/10.5817/WP_MUNI_ECON_2019-07

2019-06 Mikula, M., Montag, J. 2019. *Does homeownership hinder labor market activity? Evidence from housing privatization and restitution in Brno.* MUNI ECON Working Paper n. 2019-06. Brno: Masaryk University. https://doi.org/10.5817/WP_MUNI_ECON_2019-06

2019-05 Krčál, O., Staněk, R., Slanicay, M. 2019. *Made for the job or by the job? A lab-in-the-field experiment with firefighters.* MUNI ECON Working Paper n. 2019-05. Brno: Masaryk University. https://doi.org/10.5817/WP_MUNI_ECON_2019-05

2019-04 Bruni, L., Pelligra, V., Reggiani, T., Rizzolli, M. 2019. *The Pied Piper: Prizes, Incentives, and Motivation Crowding-in*. MUNI ECON Working Paper n. 2019-04. Brno: Masaryk University. https://doi.org/10.5817/WP_MUNI_ECON_2019-04

2019-03 Krčál, O., Staněk, R., Karlínová, B., Peer, S. 2019. *Real consequences matters: why hypothetical biases in the valuation of time persist even in controlled lab experiments*. MUNI ECON Working Paper n. 2019-03. Brno: Masaryk University. https://doi.org/10.5817/WP_MUNI_ECON_2019-03

2019-02 Corazzini, L., Cotton, C., Reggiani, T., 2019. *Delegation And Coordination With Multiple Threshold Public Goods: Experimental Evidence*. MUNI ECON Working Paper n. 2019-02. Brno: Masaryk University. https://doi.org/10.5817/WP_MUNI_ECON_2019-02

2019-01 Fišar, M., Krčál, O., Staněk, R., Špalek, J. 2019. *The Effects of Staff-rotation in Public Administration on the Decision to Bribe or be Bribed*. MUNI ECON Working Paper n. 2019-01. Brno: Masaryk University. https://doi.org/10.5817/WP_MUNI_ECON_2019-01

2018-02 Guzi, M., Kahanec, M. 2018. *Income Inequality and the Size of Government: A Causal Analysis*. MUNI ECON Working Paper n. 2018-02. Brno: Masaryk University. https://doi.org/10.5817/WP_MUNI_ECON_2018-02

2018-01 Geraci, A., Nardotto, M., Reggiani, T., Sabatini, F. 2018. *Broadband Internet and Social Capital*. MUNI ECON Working Paper n. 2018-01. Brno: Masaryk University. https://doi.org/10.5817/WP_MUNI_ECON_2018-01

ISSN electronic edition 2571-130X
MUNI ECON Working Paper Series is indexed in RePEc:
https://ideas.repec.org/s/mub/wpaper.html