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Too far to go to work? Examining the effect of changes in the time taken to commute on regional unemployment

Aleš Franc, Soňa Kukučková, Marek Litzman

MENDELU Working Papers in Business and Economics
Research Centre
Faculty of Business and Economics
Mendel University in Brno
Zemědělská 1, 613 00 Brno
Czech Republic
http://vyzc.pef.mendelu.cz/en
+420 545 132 605

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Abstract

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Time spent commuting plays a significant role in decision-making within the labour market, particularly for job seekers. Investments in road infrastructure have a direct effect on commuting times and thus may also have an effect on the local labour markets. The aim of the article is to evaluate the effect of improvements in infrastructure on regional unemployment. In this paper, we use a unique database that includes data on the time taken to commute from all municipalities in the Czech Republic (n=6237) to their regional centres for every month between March 2014 and December 2022 (106 periods). Overall 1534 changes that met the criteria for a significant change in travelling time were identified. Our results suggest that a one-minute drop in commuting time from the respective municipality to the regional centre is linked to a 0.07 percentage point drop in the unemployment rate one year later, in comparison to the control group. The ratio rises over time, after five years, the same one-minute reduction in commuting time, is then related to a 0.19 percentage point drop in unemployment. Therefore, better infrastructure can help to reduce differences in regional rates of unemployment and can justify infrastructure investments.

Key words

commuting; unemployment; road infrastructure; OSRM; New Economic Geography; inter-regional disparities; regional development

JEL: H54, R41, J61

Contacts

Aleš Franc, Department of Economics, Faculty of Business and Economics, Mendel University in Brno, Zemedelska 1, Brno, 613 00, Czech Republic, e-mail: ales.franc@mendelu.cz.

Soňa Kukučková, Department of Finance, Faculty of Business and Economics, Mendel University in Brno, Zemedelska 1, Brno, 613 00, Czech Republic, e-mail: marek.litzman@mendelu.cz.

Marek Litzman, Department of Economics, Faculty of Business and Economics, Mendel University in Brno, Zemedelska 1, Brno, 613 00, Czech Republic, e-mail: sona.kukuckova@mendelu.cz.

Introduction

Infrastructure investments and improvements are often discussed as a way to promote economic growth or development (Aschauer 1989; Barro 1990; Crescenzi, Di Cataldo, and Rodríguez-Pose 2016; European Commission 2011; Hirschman 1975; Lewis 1998) that might have an impact on the local labour market (G. H. M. Evers et al. 1987; Gerard H. M. Evers and Oosterhaven 2005). Infrastructure improvements might decrease transport costs through better accessibility and enhanced flexibility in scheduling logistics (Vickerman, Spiekermann, and Wegener 1999a). Lower overall production costs enable local businesses to be more efficient and firms, that benefit from reduced transport costs, may expand their output (Banerjee, Duflo, and Qian 2020) and increase employment (Adler et al. 2020).

However, further increases in spending on infrastructure may not always lead to the desired economic consequences. There is a critical threshold in the provision of infrastructure beyond which the impact of additional public investment on economic performance is unclear (Rodríguez-Pose, Crescenzi, and Di Cataldo 2018) for economic, political, and institutional reasons. From an economic point of view, New Economic Geography explains the asymmetric impact of infrastructure investments on different regions. Because of the ´network character´ of the spatial economy, better infrastructure may help the economic core at the expense of the periphery (Fujita and Thisse 2002; Ottaviano 2008; Puga and Venables 1997). In line with this argument, Vickerman et al. (1999) investigated the impact of the development of the Trans-European Transport network (TEN-T) on core and peripheral regions of the EU and concluded that it was not possible to confirm that TEN-T was a tool that would promote regional cohesion. Similarly, Yu et al. (2019) found that high-speed rail connections in China generate an uneven distribution effect between the peripheral and core mega cities. However, the literature that focuses on the distributional effects of large-scale investments into transport infrastructure are not clear-cut. Persyn et al. (2023) suggest that road infrastructure investments have a positive impact in Central and Eastern Europe, in the context of the European Cohesion Policy, as these investments reduce interregional disparities. The exact impact may be determined by the type of infrastructure. ´Global infrastructure´ that affects long-distance interactions mainly alter economic attraction whereas ´local infrastructure´ mainly affects accessibility (Ottaviano 2008).

The effectiveness of investments in infrastructure are significantly affected by political (Rodríguez-Pose, 2000) and institutional factors (Acemoglu and Dell 2010; Esfahani and Ramírez 2003; Rodríguez-Pose 2000). The desire of politicians to be re-elected motivates them to support large scale infrastructure projects instead of investments in local roads and maintenance of the existing infrastructure (Tanzi and Davoodi 1997). Although institutions tend to be national, they can vary within countries, especially in federated states (Acemoglu and Dell 2010). Local institutional conditions must be of an adequate quality and the effectiveness of the local political administration is crucial in the selection of appropriate infrastructure investments which will provide the desired economic returns. Economically underdeveloped regions with weak institutional environments can benefit from a convergence effect and allocate their resources to less ambitious infrastructure projects or rather to other areas of development such as education or innovation (Rodríguez-Pose, Crescenzi, and Di Cataldo 2018).

A significant proportion of the economic literature on regional labour markets sees deficiencies in local infrastructure as one of the causes of unemployment. Poor infrastructure exacerbates frictions in the labour market and worsens the matching process between employers and employees. Vice versa, infrastructure improvements can reduce the commuting time of employees and/or improve the potential for finding matches in the labour market (Holmgren and Merkel, 2017). As the willingness of workers to commute depends on the distance and duration of travel, the quality of infrastructure can affect the geographical segmentation of labour markets (Martín-Barroso et al. 2022). According to New Economic Geography, accessibility improvements may lead to the outmigration of workers from the peripheral regions to the core, rather than to job creation in the periphery (Vickerman, Spiekermann, and Wegener 1999b). Broadly speaking, according to predictions of economic theory, shortening commuting time has a positive effect on unemployment rates. However, this effect can be neutralised by various factors such as the generosity of unemployment benefits, home ownership, family structure, neighbourhoods with a high concentration of ethnic minorities, or the presence of social conflict (Martín-Barroso et al. 2022).

In general, estimates of the impact of infrastructure improvements on labour markets reveal that the direction of the causality between improvements in infrastructure and changes in output is unclear due to endogeneity (Esfahani and Ramírez 2003; Leigh and Neill 2011). Therefore, it is not certain whether a new road causes the development of a region or whether the road is built where the infrastructure investment is required due to the development of the region. Thus, it should be no surprise that different studies have found changes in the elasticity of production in different directions in response to changes in infrastructure. Holmgren and Merkel (2017) state that 23% of 776 observations in their meta-analysis found negative elasticities (e.g., Canning, 1999; Evans and Karras, 1994; Kamps, 2006; Pinnoi, 1994) and the results varied from a strong negative impact to a highly positive one. Similarly, Melo et al. (2013) conducted a meta-analysis that included 563 estimates of the effect on productivity of transport infrastructure investments and concluded that they can differ in intensity and have a negative or positive effect across countries, industry groups and modes of transport.

Based on the inconsistency of the empirical results mentioned above, we aim to test the effect of an improvement in infrastructure on regional unemployment. Unlike most of the existing literature, we base our estimates on changes in commute times as a measure of changes in infrastructure. This means that we do not evaluate the impacts of individual changes, but only their ability to save the users' time and the impact on the labour market. Thus, we evaluate all the changes we are able to identify, while only a minor proportion of them are the result of large projects such as new sections of motorway. Most of the observations come from medium and small projects that have not been studied in the majority of the currently available papers.

The empirical examination was conducted using data from the Czech which has a fragmented regional structure. The Czech Republic has the smallest average size of municipality in Europe (OECD 2018), which means that all the municipality-level data, published by authorities, are highly detailed, in international comparison, which provides us with a highly detailed view.

The empirical part of the paper is complementary to other studies examining commuting (e.g., Martín-Barroso et al., 2022), but the difference is the focus on actual changes in commute time that reflect improvements in infrastructure. Other empirical studies dealing with the impact of infrastructure investment are often limited to specific type of roads. Usually, empirical studies are concentrated on motorways (Habrman and Žúdel, 2017) and mainly on the motorways that are part of TEN-T (Balaz et al., 2018; Filčák et al., 2021; Gutiérrez and Urbano, 1996; Vickerman et al., 1999). The use of change in commuting time enables us to abstract from different types of roads and to include less commonly monitored changes in local roads. These are often not reported in the publicly available data at a national level. The results of some empirical studies have shown the different intensities of the impact that infrastructure improvements have had on small and larger municipalities (Habrman and Žúdel 2017; Martín-Barroso et al. 2022). The paper is based on a dataset that includes more than 6,000 Czech municipalities of different sizes which enables us to more fully examine the issue. The ambiguous results that have come from empirical studies about the short and long-run effects of infrastructure investment (e.g., Balaz et al., 2018; Holmgren and Merkel, 2017; Melo et al., 2013) highlight the need for further research in this area.

The paper is structured as follows: the next section presents the data and methods used in the analysis including descriptive statistics of the variables. In the following chapter, there is a discussion of the results, and the main implications of the study are outlined. Finally, the main conclusion is presented.

Data and methods

In the model, we use a unique database with data obtained from Open Street Maps. We developed our calculations on daily extracts for the Czech Republic provided by Brno University of Technology, where we used the first available extract for each month. (VUT 2023)

The Czech Republic is divided into 13 self-governing regions (NUTS 3 level) and the Capital city of Prague, which has a hybrid legal status and is both a city and a region. Every region has a capital, which is always the largest city in that region and is both the administrative and economic centre. The only exception to this principle is the Central Bohemian region, which encircles the Capital city of Prague. Thus, in this case, Prague serves as the regional capital in both administrative terms and for the purpose of our analyses.

We estimated the commuting time and distance from each municipality (n=6254) to its respective regional capital. As there are 13 regional capitals, there were 6241 estimations made for each period. We used monthly data for the period between March 2014 and December 2022, 106 time periods in total. All the times are estimated twice and averaged; routes from and to the regional capital are calculated to include the effect of asymmetries, e.g., one-way roads. This provided more than 1.3 million estimations of commuting time.

From the panel of estimates, we needed to select those municipalities that had experienced a change in commuting time. The compiled data panel contains a large number of changes that are not relevant to our analysis, mainly due to short-term route diversions, and updates or improvements in map files etc. Thus, we applied several restriction criteria to identify the changes which were to be used in the following analyses:

- The change in commuting time had to be negative, we only focused on reductions in commuting time. Although there are situations where it rises, this is not generally as a result of investments in infrastructure.
- We focused on permanent changes alone, a change had to be present for at least a year (to avoid the influence of short-term diversions and possible errors in the source data)
- Only changes greater than one minute were considered.
- Along with a change in duration there also had to be a change in distance (this effectively excludes the effects of changes in traffic signs, or speed limits, that are not a result of an investment.)
- The dataset must contain at least three years of follow-up data after the initial observation of a change in commuting time.
- If more than one change was observed, only the first was taken into account.

The spatial distribution of the identified changes is shown in Figure 1.

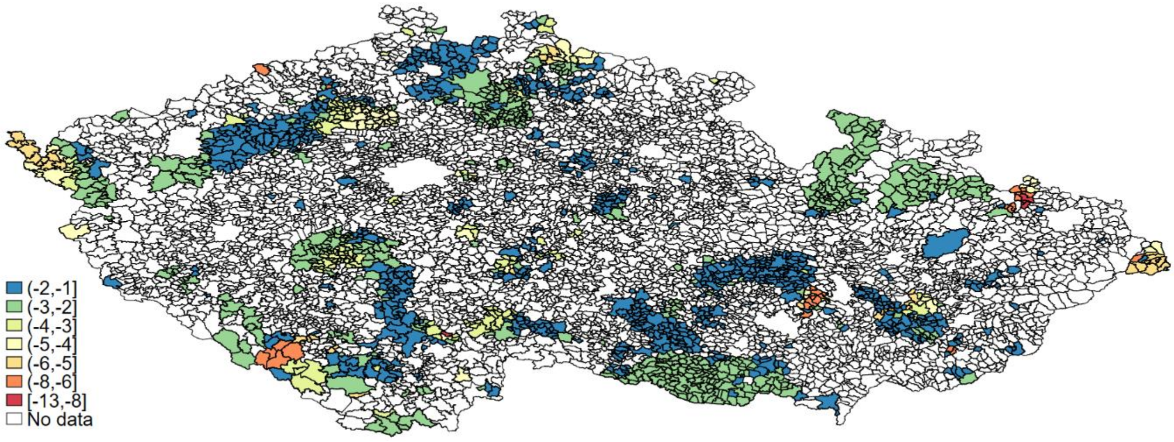

Figure 1: Observed changes in travel duration (in minutes) to the regional capital. The municipalities shown in white did not exhibit any changes.

The research question we examine in the paper is whether investments in infrastructure affect regional unemployment rates. Thus, to describe the situation in the labour markets, we use information provided by the Ministry of Labour and Social Affairs which every month publishes detailed data at a municipal level.

To estimate the effect of a change, we need to find a counterfactual to allow a relevant comparison. Nevertheless, as every change is quite unique, we use a synthetic measure. To construct the counterfactual, we divided the data into 76 smaller administrative units – districts (LAU1 level). For every observed change in commuting time, we constructed a counterfactual from all the municipalities in the respective district, that meet the following conditions:

- The municipality lies in the identical district to the municipality where the change was observed
- The counterfactual municipality did not experience any change (as described above) in commuting time in the timeframe of our dataset.

Overall, after the application of our restrictions, the dataset contained 1534 changes in commuting time and the same number of counterfactual observations.

The primary measure used to establish the effect of the change was difference-in-differences estimation. This means that for every n^{th} month, we calculated the difference between the unemployment rate u for the respective month $t+n$ and the unemployment rate at time $t0$, the month when the change in travel duration was first observed. This difference was estimated for both the municipality m and its counterfactual c. The final variable is the difference between both differences. The whole process can be written as follows:

$$DiDu_{m,c,t+n} = (u_{m,t+n} - u_{m,t0}) - (u_{c,t+n} - u_{c,t0}) \quad (1)$$

This approach leads to the results that are shown on Figure 2Figure 2. The difference at t_0 is always 0. In this specific example, for both the observed municipality and the counterfactual, unemployment decreased over time. As can be seen, unemployment in the observed municipality decreased to a lower level than in the counterfactual. Thus, the difference is negative and these values may be used in the subsequent analyses.

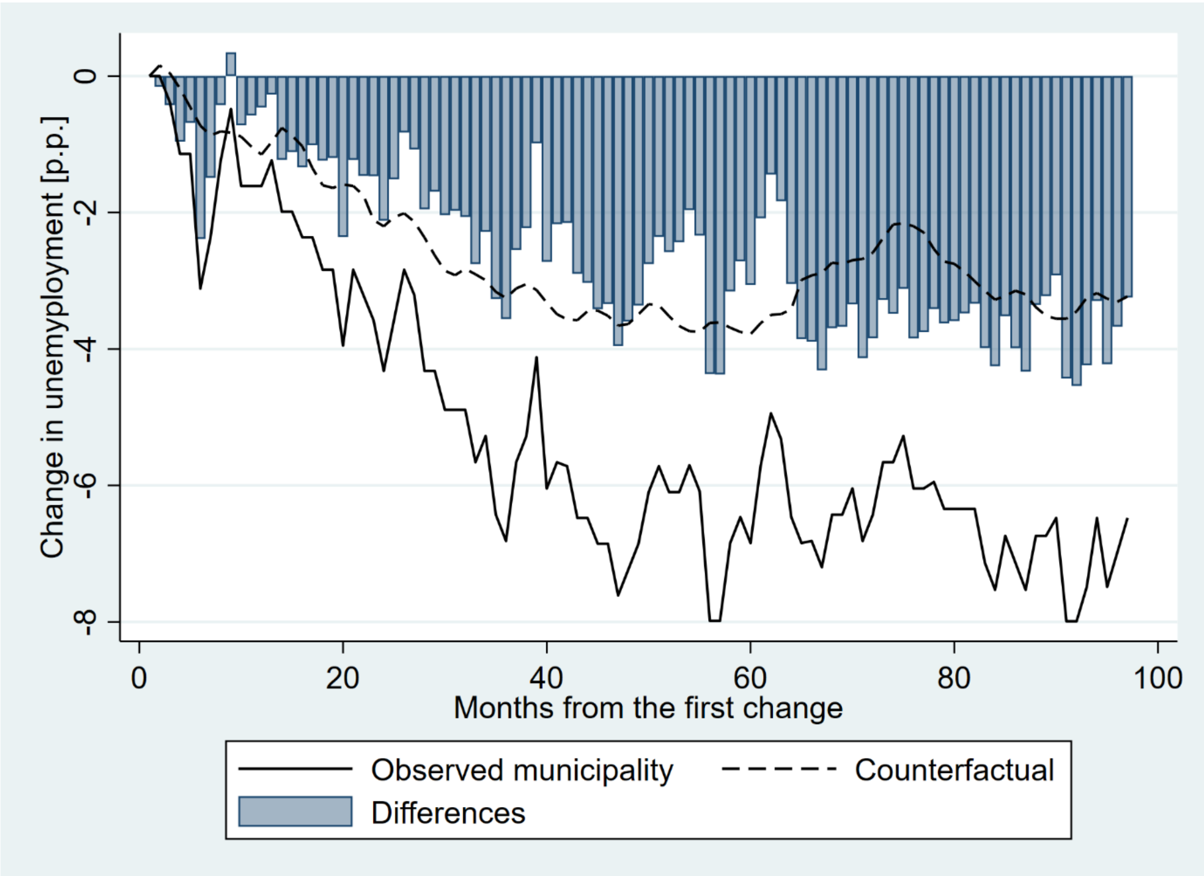

Figure 2: A graphical example of the difference-in-differences approach we used for the estimates. In this specific example of municipality , there was a greater decrease in unemployment in the observed municipality in comparison to the counterfactual, resulting in a negative difference.

To estimate the effect of the change, we used an OLS regression which explains the difference-in-differences described in equation 1. Thus, the general formula can be written as follows:

$$DiDu_{m,c,t+n} = \beta_0 + \beta_1 \Delta comtime_m + \beta_2 u_{m,t0} + \mu_i + \upsilon_t + \varepsilon_i \quad (2)$$

Where $DiDu_{m,c,t+n}$ is the difference-in-differences estimate of the change in unemployment between the municipality m and its counterfactual c at time $t+n$; β_0 is a constant of the regression, β_1 and β_2 are parameters in the equation, $\Delta comtime_m$ is the change in commuting time as defined above, $u_{m,t0}$ is the initial unemployment at the time when the change was detected, μ_i is a fixed effect of the respective region, v_t is a fixed time effect and ε_i is the error term.

Descriptive statistics for the variables used in the regression are shown in table 1. The difference-in-differences estimates can be computed for every month that follows a change in travel duration, nevertheless, the unemployment rate tends to be considerably seasonal, especially in small municipalities where just a few seasonable workers can have a significant influence on the unemployment rate. Thus, to deal with seasonality, we estimate the differences over one-year intervals. This means that the difference in unemployment, between the respective municipality and its counterfactual, is always estimated in the month when the change in commuting time was first observed. The negative value of the variable means that the observed municipality has a lower level of unemployment than the counterfactual, positive values, on the other hand, mean higher unemployment. The declining number of observations is caused by the fact that we require at least 36 months of follow-up from the observed change. Thus, some cases do not span through 48-month or 60-month periods.

The variable $\Delta comtime_m$ is estimated as the change, in minutes, of the commuting time to the regional capital. As described above, we only consider negative changes (a decrease in commuting time) greater than one minute. The greatest change we observed was 12.4 minutes.

In the regression model, we also apply a measure of the initial unemployment rate. The reason for this is the expected asymmetrical impact of changes, those municipalities with higher initial unemployment rates have more room to reduce it than those with rather low levels of unemployment (e.g. Habrman and Žúdel, 2017). According to Martín-Barroso et al. (2022) there is a greater degree of willingness to commute in areas with higher levels of unemployment which may be one of the reasons for the greater effect on unemployment.

Table 1: Descriptive statistics

Variable	Obs.	Mean	Std. dev.	Min	Max
Unemployment T+12 months	1534	-0.120	1.989	-11.905	11.952
Unemployment T+24 months	1534	0.083	2.168	-14.739	9.406
Unemployment T+36 months	1534	0.043	2.476	-17.062	10.385
Unemployment T+48 months	1453	-0.099	2.625	-29.843	11.842
Unemployment T+60 months	1332	-0.004	2.755	-23.462	9.028
Change in commuting time	1534	-2.364	1.289	-12.404	-1.005
Initial unemployment	1534	5.382	3.821	0	34.211

Results and discussion

When we only analysed the basic difference-in-differences observed in the dataset, the results did not seem to be conclusive. The average result, as seen in Table 1 is very close to zero and far from being statistically significant when compared with the standard deviation. Nevertheless, for a variety of reasons, simple averaging does not tell the whole story. Firstly, the change in duration is not a binary variable (yes or no), instead it sits within a range from one minute to more than 12 minutes, a significant degree of variation. Even more important is that the start positions are considerably heterogeneous, our dataset contains different regions that have different structural issues and some municipalities suffer from specific regional issues.

To help deal with these issues, we estimated the full model that includes initial unemployment as a control variable. This allows us to split the effects into two – the effect of the initial situation in the municipality, that is expected to determine its further development, and the effect of a change in infrastructure. The results are summarized in Table 2. As seen in the table, the main parameter we are interested in, change in commuting time, has a significant relationship with the rate of unemployment (as described in equation (1). A positive sign indicates that a decrease in commuting time is related to a reduction in unemployment (unemployment in the respective municipality is lower than its counterfactual). The parameter ranges from 0.071 to 0.197 and tends to gradually increase during the first three years after the identification of the change. After the third year, the decline in unemployment tends to remain stable at around 0.2 percentage points. Taking the first equation as an example, the result can be interpreted as follows: in the first year after a change in commuting time was first observed, a one-minute decrease in commuting time was associated with a reduction in unemployment that was 0.071 percent lower in the respective municipality when compared to its counterfactual. This corresponds with the findings (Holmgren and Merkel 2017b) that better infrastructure and reduced commuting time enables more effective matching in local labour markets. The effect on unemployment is higher in the long run, which is compatible with the findings of (Balaz, Nezinsky, and Dušana Dokupilová 2018b; Fujita, Krugman, and Venables 1999; Habrman and Žúdel 2017)

The control variable, initial unemployment rate, is significant and negative in all model specifications. Thus, if the initial level of unemployment is high in the municipality, then there is a greater difference after a change in commuting time. The results are in line with Martín-Barroso et al. (2022) who stated that commuting times tend to increase when a worker resides in a municipality with a high level of unemployment. Indeed, the initial unemployment rate is crucial for its possible decrease; it is virtually impossible to decrease unemployment when the initial rate of unemployment is close to zero. Time and regional fixed effects were included in all the model specifications.

Table 2: Regression results, the dependent variable is the unemployment differential after different time periods after the detection of a change in commuting time.

	T+12 months	T+24 months	T+36 months	T+48 months	T+60 months
Change in commuting time	0.071+	0.108*	0.197***	0.174***	0.188***
	(0.095)	(0.014)	(0.000)	(0.000)	(0.000)
Initial unemployment	-0.097***	-0.213***	-0.319***	-0.426***	-0.441***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Constant	0.437	1.765***	2.799***	3.643***	3.523***
	(0.175)	(0.000)	(0.000)	(0.000)	(0.000)
Time fixed effects	Year	Year	Year	Year	Year
Spatial fixed effects	Region	Region	Region	Region	Region
N	1534	1534	1534	1453	1336
R2	0.066	0.159	0.238	0.293	0.315

p-values in parentheses. + p<0.10, * p<0.05, ** p<0.01, *** p<0.005

As was noted above, our approach does not distinguish between small-scale or large-scale projects as we only examine the effect on commuting time. As this differs from most of the published studies, we also tested the possible additional impacts of larger-scale projects. There may be reasons why larger projects have a stronger impact on unemployment. Usually, they are more loudly discussed in the media and gain a greater degree of political attention than small changes in local infrastructure, as a consequence the public is more aware of the changes (Tanzi and Davoodi 1997). In addition, some of the empirical studies could serve as a basis for politicians to justify large-scale infrastructure investments to their voters (Gutiérrez and Urbano 1996; Leigh and Neill 2011). This may result in such changes having a greater effect on unemployment.

For this reason, we included a dummy variable as a control for these situations, where the change is induced by a new section of motorway (n=196); motorways are the backbone of the national road network. As can be seen in Table 3, the results do not support the idea that large-scale projects have a greater impact. The dummy variable introduced as a control for motorway changes is insignificant in all model specifications with both positive and negative signs. The addition of the dummy variable had almost no effect on the parameters and significance of other variables. This means that the scale of the project does not seem to be a predictor of a change in unemployment – what matters is the time saved by commuters, not the type of new road. This is in contrast to the results presented by Balaz et al. (2018a), who argued that a connection to the TEN-T has a greater effect on unemployment than a mere change in commuting time in general.

Table 3: Regression results, the dependent variable is the unemployment differential after different time periods after the detection of a change in commuting time, testing the motorway dummy.

	T+12 months	T+24 months	T+36 months	T+48 months	T+60 months
Change in commuting time	0.070+	0.110*	0.200***	0.170***	0.190***
	(0.100)	(0.012)	(0.000)	(0.001)	(0.000)
Initial unemployment	-0.097***	-0.213***	-0.318***	-0.427***	-0.441***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Highway dummy	-0.037	0.126	0.159	-0.307	0.128
	(0.882)	(0.626)	(0.571)	(0.310)	(0.703)
Constant	0.431	1.784***	2.822***	3.600***	3.541***
	(0.184)	(0.000)	(0.000)	(0.000)	(0.000)
Time fixed effects	Year	Year	Year	Year	Year
Spatial fixed effects	Region	Region	Region	Region	Region
N	1534	1534	1534	1453	1336
R^2	0.066	0.159	0.238	0.294	0.315

p-values in parentheses. + p<0.10, * p<0.05, ** p<0.01, *** p<0.005

To further analyse the results, we focused on a more detailed grouping of observations. We divided the dataset into five categories based on population size. Czech municipalities are extremely small (OECD 2018); as seen in Table 4, the vast majority of the studied municipalities have a population of less than 1000.

As can be seen in Table 4, within most of the model specifications, the sign of the main variable, change in commuting time, remains positive. The significance differs – unemployment in the group of municipalities with the smallest populations does not appear to be significantly influenced by changes in commuting time. This may be due to the heterogeneity of municipalities with small populations and their sensitivity to small changes. When we consider a municipality with a population of 200, the largest unit in the first subgroup, the workforce averages a hundred people (the average ratio of workers to total population in the Czech Republic is about 50%). In this case, every single worker is approximately one percentage point of the unemployment rate. Thus, a change that is negligible from a macroeconomic point of view, i.e., the bankruptcy of a small firm with several employees, can have a strong impact on the unemployment rate in such a small municipality. Such heterogeneity leads to a high level of deviations and thus to the low significance of the variable.

The strongest effect can be observed in the groups with population sizes of 200 to 500 and 500-1000. We expect that those groups contain municipalities that are large enough to be reasonably stable, but at the same time are too small to be self-sufficient in terms of the labour market. Our results are consistent with Habrman and Žúdel (2017) who highlighted the situation in urbanized districts where highway construction has a lesser effect on unemployment. This is related to the higher education and skill level of the citizens in comparison to those in rural areas which enables their inhabitants to find a job more easily.

Table 4: Regression results, the dependent variable is the unemployment differential 36 months after the identification of a change in commuting time. The regressions were run on subsamples of different population sizes.

	T+36 months	T+36 months	T+36 months	T+36 months	T+36 months
Change in commuting time	0.265+ (0.088)	0.309*** (0.000)	0.129+ (0.089)	0.003 (0.954)	-0.002 (0.984)
Initial unemployment	-0.383*** (0.000)	-0.266*** (0.000)	-0.221*** (0.000)	-0.333*** (0.000)	-0.196+ (0.051)
Constant	3.849*** (0.000)	2.540*** (0.000)	1.720*** (0.003)	2.396*** (0.000)	0.480 (0.698)
Time fixed effects	Year	Year	Year	Year	Year
Spatial fixed effects	Region	Region	Region	Region	Region
Population	Below 200	200-500	500-1000	1000-5000	Above 5000

N	372	518	319	264	56
R^2	0.245	0.239	0.324	0.451	0.595

p-values in parentheses. + p<0.10, * p<0.05, ** p<0.01, *** p<0.005

Conclusion

Investments in infrastructure are often seen as an important factor that contributes to regional economic development. A better-quality infrastructure enables transport costs to be reduced, increases productivity, and intensifies competition. From the perspective of regional policy, transport infrastructure investments are considered to be a way to enhance social cohesion. Shortening the distance and time of the daily commute, for all the groups of commuters, might have a strong beneficial role in regional development, especially in the inner peripheries and other underdeveloped areas.

In the paper, we developed an approach to test the effect of shortening commutes by road infrastructure investment and the outcome in the labour market. Using Open Street Maps data, we were able to estimate commuting times from every municipality in the Czech Republic to the regional centre. Studying the period from March 2014 to September 2022, we identified 1534 municipalities that saw a significant decrease in commuting time to the regional centre. When examining the data, we found that 12 months after a reduction in commuting time, the local unemployment rate dropped by 0.07 percent for a one-minute reduction. This effect is even more pronounced over longer periods of time. Thus, after three years, we identified a reduction in the local rate of unemployment of approximately 0.2 percentage points for reduction in commuting time of one minute.

The results remained stable within several alternative scenarios, for example when controlled for the scale of infrastructure projects or the size of the municipality. Overall, we found that shortening the commuting distance has the greatest benefit for middle-sized towns with the population of 200 to 500

The results suggest that infrastructure investments do have a positive effect on local labour markets. A higher degree of worker mobility leads to a reduction in the unemployment rate of municipalities over the medium term. The results suggest that not only major infrastructure projects, that are broadly examined in the current literature, but also local projects can have a significant contribution to the reduction of regional disparities.

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