Are new highways beneficial for regional economic development?

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Abstract: In 2007, a new 50-kilometer section of highway connecting Prague and Hradec Králové was opened to the public. This notably reduced travel time between these two cities by approximately 15 minutes. Employing a rigorous analytical approach that combines the difference-in-differences methodology based on the synthetic control method with panel regression techniques, this study investigates the impact of this highway expansion on regional economic dynamics, namely the pace of firm establishments. According to our results, the faster travel facilitated by the new highway had the consequence of slowing the pace of firm creation in municipalities lying close to the highway, which were able to benefit from faster travel times. We expect that the introduction of the new highway segment amplified the gravitational pull of major urban centers, attracting economic activity away from the surrounding regions.

Keywords: Commuting time, highway, road infrastructure, economic development, firm creation
JEL Classification: H54, R41, J61

1 Introduction

It is widely acknowledged that investments in transportation infrastructure play a pivotal role in driving economic growth (Aschauer 1989; Barro 1990; European Commission 2011; Ciani, de Blasio and Poy 2022). Enhanced infrastructure not only diminishes the time and financial burdens associated with transportation for both individuals and businesses (Gunasekera, Anderson and Lakshmanan 2008) but also facilitates the expansion of trade and transportation distance of companies (Pol 2003). This expansion grants producers access to more distant markets and allows them to source inputs from broader geographical areas, which may stimulate local production (Hong, Chu and Wang 2011). This argumentation, which is based on classical localization theory, assumes a high social return on investment in transport infrastructure, thus justifying the necessity of state intervention in this sector.

However, it is crucial to recognize that new infrastructure projects not only influence the overall level of economic activity but also shape its spatial distribution (Ciani, de Blasio and Poy 2022). Some firms located in more developed regions may indeed benefit from reduced transportation costs, enabling them to access new markets and supply more remote regions from greater distances. However, investments in transport infrastructure, especially in significant projects like new highways, may not necessarily lead to a reduction in regional disparities. Instead, they often promote further economic development in core areas while complicating the growth of economic activities in remote and disadvantaged regions. In evaluating the effectiveness of infrastructure investments, it is important to consider other factors of regional development, including educational, innovative, and institutional variables (Crescenzi and Rodríguez-Pose 2012; Crescenzi, Di Cataldo and Rodríguez-Pose 2016).

Empirical studies further substantiate the notion that new infrastructure projects do not guarantee equitable regional economic development. For instance, Pereira and Andraz (2005), in their examination of the consequences of infrastructure investment in Portugal, confirm economic development in the Lisbon metropolitan area and improved macroeconomic outcomes, but at the cost of persistent regional disparities. Similarly, the study conducted by Ciani, de Blasio and Poy (2022) reveals that the A3 Salerno-Reggio Calabria highway, constructed between 1962 and 1974, primarily led to the relocation of population and economic activities to areas adjacent to the highway, rather than fostering growth throughout the entire region. Mičúch and Tvrz (2015), in their analysis of the expansion of the highway network in Slovakia from 1995 to 2014, do not confirm a clear and enduring impact of new highways and expressways on the unemployment rate. Their findings suggest that, up until 2009, the introduction of new expressways did contribute to a

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reduction in the unemployment rate in neighboring districts (by 0.6% for highways and 0.4% for expressways), but this effect did not extend beyond a two-year horizon.

The literature indicates that high-speed communications play a crucial role in promoting the decentralization of economic activities (Baum-Snow, Freedman and Pavan 2018). However, it's important to note that they can also put distant localities at a disadvantage (Baum-Snow 2007). The main point to emphasize is that as new economic hubs develop, it can come at the expense of areas that are pushed towards the periphery (Redding and Turner, 2015). Infrastructure projects, particularly new ones, have a significant impact on the equilibrium between forces that encourage agglomeration and those that promote dispersion. Consequently, they can hinder the industrialization of peripheral areas. To enhance the competitiveness of domestic companies, supporting intra-regional transport networks may prove to be a more prudent solution (Vickerman, Spiekermann and Wegener 1999).

Towards the close of 2006, a new 50-kilometer stretch of highway linking Prague and Hradec Králové was made accessible to the public. This fresh infrastructure project had the remarkable effect of trimming the travel time between these two cities by an estimated 15 minutes while, making substantial enhancement to the quality of the road network in the surrounding regions. In this paper, our primary objective is to examine the impact of this transformation on economic development within the affected areas. As the literature survey has shown, the impact can manifest in a dual manner. On one hand, the newfound connectivity may serve to bolster economic activity within the region. On the other hand, it may trigger a migration of economic activities towards more sizable economic centres, particularly the large capital city of Prague, which is expected to have a strong gravity towards economic activities.

2 Methodology

In this chapter, we present the methodological framework employed to investigate the impact of a new highway segment on the economic activity in specific municipalities affected by an examined change. The economic activity within these municipalities is proxied through changes in the number of existing firms as its main drivers. To facilitate this analysis, we utilize data collected at the level of administrative units known as municipality with extended power ("obec s rozšířenou působností", abbreviated as ORP), which are municipalities endowed with enhanced rights and responsibilities in public administration, effectively serving as administrative centres for their respective microregions. These administrative units, from the systematic point of view, are smaller in compared to districts (LAU1) yet encompass several municipalities (LAU2). We use this level of aggregation as the Czech statistical office publishes more elaborate data on this level, than on a level of single municipalities – including data on a number of active firms that are crucial in our research.

To assess the causal effect of the new highway segment on firm creation, we have developed a methodological approach based on the difference-in-differences (DID). In this research framework, we construct synthetic control measures as counterfactuals for evaluation purposes. The synthetic control approach enables us to construct a hypothetical control group that closely resembles the treated municipalities but did not experience the introduction of the new highway. Synthetic control measures are constructed for each treated ORP based on a weighted combination of control municipalities based on several criteria, that should, through the optimalisation process, create the synthetic control resembling the original ORP. Namely, they are listed in table 1.

Table 1 List of variables used for the synthetic control estimation

Variable	Unit of measure
Number of municipalities in ORP	Number
Acreage of land	Hectars
Population density	Inhabitants/km^2
Unemployment rate	Percentage
Number of completed dwellings	Number per 1,000 inhabitants
Increase by moving	Number
Natural population increase	Number
Average age - men	Years
Average age – women	Years
Vacancies	Number

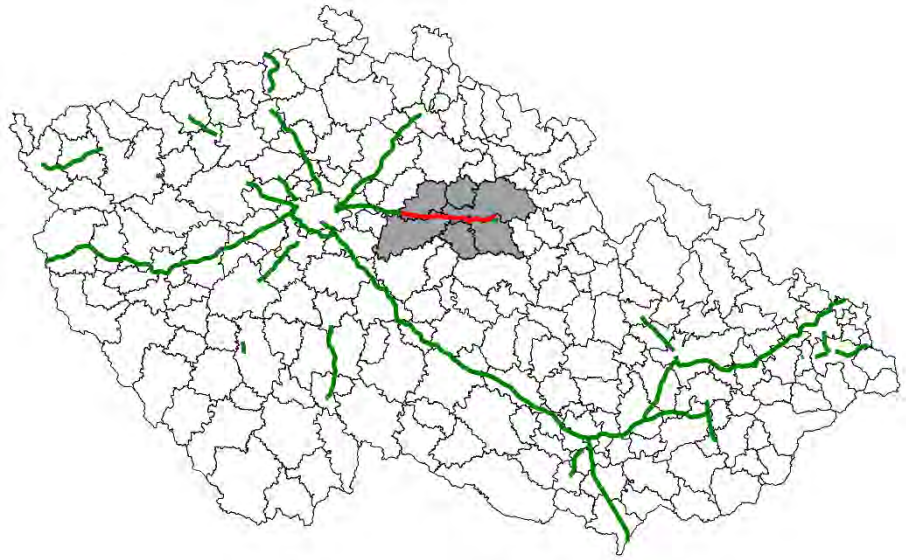
All the variables were obtained from the Czech statistical office regional database and all of them are at the level of ORP, as described above. Using the synthetic control estimated using Stata "Synth" package, we were able to estimate the following model:

$$\Delta \frac{subjects_{i,t}}{inhabitants_{i,t}} = \beta_0 + \beta_1 \Delta synth \left(\frac{subjects}{inhabitants}\right)_{i,t} + \beta_2 dummy_t + \beta_3 dummy_t * years + \mu_t + \epsilon_i + \varepsilon_{i,t} \quad (1)$$

Where $\Delta \frac{subjects_{i,t}}{inhabitants_{i,t}}$ is a first difference of the number of economic subjects located in ORP i in year t divided by number of inhabitants in the same territory and time, β_0 is a constant of the regression, β_1, β_2 and β_3 are parameters of the regression, $\Delta synth\left(\frac{subjects}{inhabitants}\right)_{i,t}$ is the first difference of synthetic control of the proportion of number of economic subjects and number of inhabitants in respective municipality, $dummy$ is a dummy variable marking years in which the new section of highway was already in use, $dummy_t * time$ is the interaction term, where dummy is multiplied by number of years from the highway opening, μ_t are time fixed effects, ϵ_i are spatial fixed effects and $\varepsilon_{i,t}$ is the error term.

In our research, we have turned our lens toward six selected ORPs within the Czech Republic that lie along the newly opened piece of highway. These ORPs, which play a main role in our investigation, encompass Hradec Králové, Nový Bydžov, Kolín, Přelouč, Pardubice, and Poděbrady. Overall, there are 205 ORPs in the Czech Republic, the rest of them serve as a base for synthetic control calculation. They effectively serve as a counterfactual in our estimations, enabling us to compare the economic dynamics of the treated ORPs (those directly influenced by the new highway segment) with the expectations based on this counterfactual. To offer an overview of the context, Figure 1 depicts the overall situation. It represents the distribution of ORPs across the Czech Republic, highlighting the six selected ORPs in our research.

Figure 1 Map of the Czech republic with highlighted ORPs affected by the new highway section (in grey, new highway section highlighted in red)



Our analyses use the data spanning between the years 2002 to 2021. This specific timeframe was chosen due to the availability of comprehensive statistics at the ORP level from the Czech Statistical Office. These years mean 20 distinct periods shrinking to 19 after differencing, comprising 5 years leading up to the change of interest and an ensuing 14-year period following this transformative event. With our study focusing on six specific ORPs, this results in a total of 114 observations.

In order to provide a structured overview of our dataset, we present detailed descriptive statistics in Table 2. This table serves as a reference point, offering insights into the key characteristics of our data. Both the treated values and the synthetic control values are presented in first differences, as described in Equation 1. This approach captures rather the changes over time than the actual values, allowing us to overcome the issue of non-stationarity of our data.

Upon close examination of the descriptive statistics, the means of the changes in both the treated and synthetic control variables are very similar as well as the standard deviations, showing no obvious difference straight from the descriptives.

Table 2: Descriptive statistics

Variable	Obs	Mean	Std. dev.	Min	Max	Skewness	Kurtosis
ΔSubjects p.c.	114	0.0027	0.0033	-.0046	0.0139	0.7631	4.5918
ΔSynthetic control	114	0.0026	0.0033	-.0069	0.0119	0.2816	4.6112
Dummy	114	0.75	0.4348	0	1	-1.1547	2.3333
Interaction	114	6	5.120	0	15	0.2715	1.6858

3 Results

Our analysis, conducted in accordance with the methodological framework previously described, yielded a series of regression estimations aimed at unravelling the impact of the newly constructed highway segment on firm creation rates within specific ORPs. We present a summary of these estimations in the table 3, shedding light on the nuanced relationship between transportation infrastructure and economic performance in regions.

The initial set estimations (1 and 2) is conducted without fixed effects. They revealed that the synthetic control proved to be a significant predictor of actual values. Notably, the inclusion of a basic dummy variable yielded a significant negative coefficient. This intriguing result implies that municipalities located in ORP administrative units that gained swifter connections to larger cities experienced a slower pace in firm creation compared to what would be expected based on the counterfactual. Building upon the first estimation, we introduced an interaction term. However, this term did not achieve statistical significance, indicating that the interaction between the highway segment and time had no substantial impact on firm creation rates in this model specification.

To capture the specifics of particular years, we incorporated time fixed effects into the analysis. Interestingly, these fixed effects supplanted the significance of the synthetic control variable. Nevertheless, the dummy variable remained both significant and negative in this particular regression, suggesting that the pace of firm creation remained lower in treated ORPs as compared to the counterfactual. After the introduction of the interaction term, we found that it, in contrast to estimation 2, became statistically significant. Together with the persistently significant and negative dummy variable, this result implies that while the initial impact of the new highway segment was associated with a decrease in firm creation rates in treated ORPs, this disparity slightly weakened over time, probably finding a new equilibrium.

The final estimations 5 and 6 introduced spatial fixed effects. Overall, the inclusion of these effects did not substantially alter the results observed in previous estimations, both in terms of coefficients and significance. The key variables of interest, the dummy and interaction terms, remained stable.

Table 3: regression results, dependent variable is a first difference of a number of economic subjects per inhabitant in respective ORP

	(1) ΔSubjects p.c.	(2) ΔSubjects p.c.	(3) ΔSubjects p.c.	(4) ΔSubjects p.c.	(5) ΔSubjects p.c.	(6) ΔSubjects p.c.
ΔSynthetic control	0.644*** (0.000)	0.656*** (0.000)	-0.152 (0.225)	-0.152 (0.225)	-0.178 (0.169)	-0.178 (0.169)
Dummy	-0.001* (0.011)	-0.001 (0.417)	-0.006*** (0.000)	-0.071*** (0.000)	-0.006*** (0.000)	-0.073*** (0.000)
Interaction		-0.000+ (0.076)		0.004*** (0.000)		0.004*** (0.000)
Constant	0.002*** (0.000)	0.002*** (0.000)	0.013*** (0.000)	0.013*** (0.000)	0.013*** (0.000)	0.013*** (0.000)
N	114	114	114	114	114	114
R^2	0.514	0.528	0.721	0.721	0.721	0.721
FE	No	No	No	No	Yes	Yes
Time FE	No	No	Yes	Yes	Yes	Yes

A question may arise when interpreting our findings: to what extent are our results influenced by the presence of two large ORPs – Pardubice and Hradec Králové – both of which encompass sizable towns and serve as regional capitals? These larger ORPs undoubtedly wield substantial economic influence within their regions. Moreover, it is essential to consider that while both larger and smaller ORPs experienced better connection to the capital city of Prague, smaller ORPs also benefited from improved access to the above-mentioned regional capitals. To address this dynamic, we executed separate regression analyses—one set focused on the four smaller ORPs and another set solely dedicated to the two larger ORPs. The results of these distinct analyses are presented in Table 4.

Within this set of estimates, the differences emerge. In the case of the four smaller ORPs, the results echo the patterns observed in our previous analysis. Specifically, in regressions labeled 1a and 2a, encompassing these smaller municipalities, the key dummy variable remains statistically significant, retaining its negative coefficient and maintaining a numerical resemblance to our prior findings. This persistence underscores that the inclusion of larger towns did not significantly alter the observed effects.

Conversely, when we shift our focus to the two larger ORPs, a notable departure from the previous results becomes evident. In this scenario, the dummy variable fails to achieve statistical significance, exhibiting a lack of impact on firm creation rates. Moreover, the sign of the dummy variable varies across different variants of these regressions. This contrast

suggests that the swifter connection to the capital city of Prague did not affect on the pace of firm creation within the context of larger towns. Simultaneously, the results imply that smaller municipalities experienced a substantial influence, as they found themselves subject to a notable economic drain facilitated by their improved connection to both the capital city and the larger towns of Pardubice and Hradec Králové.

Table 4: regression results, dependent variable is a first difference of a number of economic subjects per inhabitant in respective ORP, dataset is divided into two parts, small (regressions 1a and 2a) and large ORPs (regressions 1b and 2b)

	(1a) ΔSubjects p.c.	(2a) ΔSubjects p.c.	(1b) ΔSubjects p.c.	(2b) ΔSubjects p.c.
ΔSynthetic control	-0.227 (0.128)	-0.227 (0.128)	0.657+ (0.097)	0.657+ (0.097)
Dummy	-0.008*** (0.000)	-0.065** (0.008)	0.001 (0.722)	-0.042 (0.219)
Interaction		0.004* (0.020)		0.003 (0.203)
Constant	0.014*** (0.000)	0.014*** (0.000)	0.003 (0.489)	0.003 (0.489)
N	76.000	76.000	38.000	38.000
R^2	0.727	0.727	0.905	0.905
FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
Sample	Without large ORPs	Without large ORPs	Large ORPs only	Large ORPs only

4 Conclusions

In this concluding chapter, we summarize the key aspects of our research, which has investigated the impact of a new highway segment on the pace of firm creation in specific municipalities affected by this change. Our analysis has revolved around the utilization of a methodological framework anchored in the difference-in-differences (DID) approach, complemented by synthetic control measures as counterfactuals for our evaluation. Our study has been based on a dataset collected at the level of administrative units known as municipality with extended power (ORP), which serve as administrative centers for their respective microregions.

Initial estimations conducted without fixed effects showcased the significance of the synthetic control variable and the negative coefficient of the dummy variable. This finding suggested that municipalities within treated ORPs that gained swifter connections to larger cities experienced a decrease in the pace of firm creation compared to the counterfactual. After the incorporation of time and spatial fixed effects, results revealed that the initial impact of the new highway segment was associated with a decrease in firm creation rates in treated ORPs, although this effect slightly weakened over time, likely finding a new equilibrium. The introduction of spatial fixed effects over time had minimal impact on our results, reaffirming the stability of our findings.

A secondary question arose regarding the influence of two larger ORPs, Pardubice and Hradec Králové, both serving as regional capitals and encompassing sizable towns. Our subsequent analysis divided the ORPs into two categories: smaller ORPs and larger ORPs. While the findings for smaller ORPs echoed our prior results, larger ORPs exhibited distinct patterns. In these larger municipalities, the dummy variable failed to achieve significance, indicating that the swifter connection to the capital city of Prague did not affect firm creation rates in their case. Conversely, smaller municipalities experienced a substantial influence, characterized by notable economic outflows facilitated by improved connections to both the capital city and the larger towns of Pardubice and Hradec Králové.

In conclusion, our research sheds some light on the dynamics between transportation infrastructure development and regional economic activity within the Czech Republic. It underscores the differentiated impacts experienced by municipalities of varying sizes and roles within their respective regions.

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