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The Effects of Highway Construction in the Balkans: Insights from the Via Militaris[*]

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Abstract:
The economic effects of the construction of modern road transport infrastructure in the Balkans, one of Europe's economically most backward regions, is being analysed in an instrumental variables setting. In order to avoid endogeneity the construction of new highways is being instrumented by the proximity to the major ancient Roman road network that was originally constructed mainly for military purposes, such as the Via Militaris that used to run diagonally through the Balkan Peninsula. First results for Croatian municipalities in the period of analysis between the two census years of 2001 and 2011 suggest that the construction and opening of new highway sections had not only substantial positive economic effects, as measured by the change in employment, on the municipalities where the construction took place but also on the neighbouring municipalities.
Keywords: Economic Development, Southeast Europe, Transportation Economics
JEL-Classification: N74, O18, R42

Introduction

Rosenstein-Rodan (1943) in his seminal paper on the 'Problems of Industrialisation of Eastern and South-Eastern Europe' introduced the theory of the 'Big Push'. He proposed the creation of an 'Eastern European Industrial Trust' for capital investment in the region to be set up after WWII. The coordinated investments of the trust were to concentrate on the building of 'basic industries and public utilities'. The simultaneous industrialisation of many sectors could then make industrialisation profitable even if none of the single sectors could break even by themselves. Shared public infrastructure, such as railways or roads, could make industrialisation more likely to happen.

Several studies have provided empirical evidence of the positive impact of infrastructure on the economic development of nations. Barro (1989) used *inter alia* the average ratio of public investment in GDP as a proxy for government infrastructure spending to explain real GDP growth. The estimated coefficient of that variable was significantly positive. However, more recent literature deals with the issue of endogeneity of infrastructure investment to economic development as the causality might well run into the opposite direction. This can be overcome by using an instrumental variables approach.

Often exogeneity of instruments is rooted in historical military plans that caused the development of the respective infrastructure but that are not directly correlated with the economic outcome of interest. Thus, for instance Baum-Snow (2007) and Michaels (2008) have analysed the effects of US interstate highways, where a 1947 national defence plan provides for the exogenous variation. Donaldson (2010) analyses the impact of railroad infrastructure in India taking advantage of the accepted fact that the original placement of the infrastructure was motivated primarily by military concerns of the British colonial government.

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Most recently, Volpe Martincus et al. (2013) have provided evidence for present-day Peru based on the ancient Inca road network and suggested that improvements in road infrastructure have had a significant impact on local firms' exports and thereby on job creation. *Inter alia* they have instrumented the regional change in road infrastructure between 2003 and 2010 with the distance from the geographical origin of the respective firm's exports to the nearest road that was part of the Inca network.

Inspired by this, we would like to do similar work on transport infrastructure in the Balkans, where the main highways were and are being built along ancient Roman routes. These roads are perfect instruments as initially Roman roads were built mainly to support military actions, as transportation between towns and army camps was an essential requirement for the conduct of military campaigns (Berechman, 2003). In fact the name of the main Roman road to cross diagonally the Balkans was Via Militaris.

The Via Militaris (see Appendix maps 1, 2 and 3) ran from Byzantium / Istanbul via Philippolis / Plovdiv, Serdica / Sofia, Naissus / Niš to Singidunum / Belgrade and Sirmium / Sremska Mitrovica, where it was connected to the major Italian road networks via the Via Pannonia (see Appendix maps 1 and 4), running through Siscia / Sisak, all the way to Aquileia (Deluka et al., 2003). From there a southern route, the Via Flavia (see Appendix maps 1 and 4) was following the coast line via Pola / Pula, Tarsatica / Trsat-Rijeka, ladera / Zadar, Salona / Solin-Split, all the way to Dyrrhachium / Durrës. The rhomboid was closed with the Via Egnatia (see Appendix maps 1 and 2) that connected Dyrrhachium and Byzantium via Thessalonica / Thessaloniki. There have been a number of smaller roads also in the inner parts of the Balkan Peninsula (see e.g. Dzino, 2010) but these were of less strategic importance.

In a first step we will analyse the economic effects of investment in highway infrastructure on 2001 and 2011 census data at the level of Croatian municipalities. In a second step we will also include Serbia and Bulgaria for which data is easily available from national statistics. We will also try to acquire data for the remaining Balkan countries, some of which lack however longer time series of regional data and have changed administrative and statistical regions recently, which makes a comparison over time difficult. However, both the main parts of the ancient Roman road network as well as the present day's highway network in the Balkans are concentrated especially in Croatia but also in Serbia and Bulgaria.

Empirical model

Following the methodology of Volpe Martincus et al. (2013) we will estimate:

$$\Delta labour_{mc} = highway_{mc} + control_{mc} + country_{c} + \varepsilon_{mc}, \quad (1)$$

where $\Delta labour_{mc}$ is the percentage change of employment between the years 2001 and 2011 for municipality *m* and country *c*. The dummy variable *highway* takes the value of one (otherwise zero) if during the period of analysis a new highway section was built and opened for traffic in the respective municipality. A number of *control* variables for the initial year of 2001 are being included as well as a dummy variable for *country* fixed effects. This corresponds to a difference-in-difference estimation, whereby the before and after change in employment of municipalities

whose highway length did not change is used as an estimate of the counterfactual for the municipalities with an increased availability of high quality road infrastructure.

As discussed above, our main explanatory variable *highway* can be endogenous to the economic outcome as proxied by *labour*. In order to isolate a source of variation in road infrastructure that is exogenous with respect to employment, we use as an instrument a variable related to the Roman road network. Hence our first stage equation is the following:

$$highway_{mc} = roman_{mc} + control_{mc} + country_{c} + \varepsilon_{mc}, \quad (2)$$

where *roman* is the distance between the respective municipality capital and the nearest place along a major Roman road in kilometres. Following Volpe Martincus et al. (2013) a linear model is used to estimate the binary treatment variable in the first-stage equation. According to Angrist (2001, 2006) linear two stage least squares estimates have a robust causal interpretation that is insensitive to the possible nonlinearity of the first-stage conditional expectation function.

Data

For our first step analysis that only covers municipalities from Croatia we mostly employ census data for the year 2001 (first census year after the end of the Yugoslav wars) and 2011 (second census year after the end of the Yugoslav wars) as provided by the Croatian Bureau of Statistics. On the municipality level these statistics mostly contain basic population data. Hence we have extracted information on total population and the number of persons engaged in occupation / employed for both years. In a few cases there have been partitions of municipalities and we had to calculate changes between the two years based on the year 2001 definition of 562 municipalities (including towns and capital city districts). For the initial year of 2001 we have also collected a number of control variables such as secondary and tertiary school attainment of population aged 15 and over or the population number of the Serb minority. There is also the information whether a municipality is classified as a town or not. From the regular publications of the Croatian Bureau of Statistics we have in addition gathered information on the total number of 2001 tourist arrivals by municipality. Being part of the capital city agglomeration was defined by membership in the County and City of Zagreb. Being part of a county that was affected by the war in the 1990s qualifies a municipality for the war dummy variable.

The position of places along the major Roman roads was determined with the help of the road maps provided by the Ancient World Mapping Center, which are based on Talbert (2000), as well as information provided by Deluka et al. (2003) and Dzino (2010). The position of places along the modern highway built between 2001 and 2011 was determined with the help of the ARKOD parcel identification project maps and publicly available information on the opening dates of the single highway sections from various sources. Geographical location data (i.e. information on the geographic coordinates of longitude and latitude) for most of the places identified, including the capitals of the municipalities was taken from open source data as provided by MaxMind. For the remaining places an online Latitude Longitude Finder was employed. With all the above information minimum distances from each municipality's capital to both the nearest place along the major ancient Roman road network as well as the nearest place at a newly built highway segment was calculated. None of the distances have an exact value of zero, there are at least

tiny discrepancies, and hence taking logs of the distance information does not cause observation losses.

Results

From the original set of 562 municipalities we had to exclude 23 municipalities with employment growth rates between 2001 and 2011 of above +50% and below -50% as extreme outliers. Their inclusion would have violated OLS assumptions. The eliminated municipalities are to a large extent located in the East and the South of Croatia, in or close to areas with larger Serb minority population that were affected by the war in the 1990s and that have seen quite some population change of different directions in the 2000s.

Table 1: Summary statistics for 539 Croatian municipalities

	Median	Mean	Std. Dev.
Employment change in pp. 2001/2011	-8.7	-9.3	19.8
Change in employment rate in pp. 2001/2011	4.9	3.7	6.3
New highway dummy	0	0.158	-
Distance new highway	13.8	19.1	18.6
Distance Roman road	22.2	29.2	25.4
Capital city agglomeration dummy	0	0.093	-
Town dummy	0	0.258	-
Secondary school attainment share, 2001	33.5	33.4	7.9
Tertiary school attainment share, 2001	4.0	5.3	4.3
Tourist arrivals share in population, 2001	0.0	273.5	817.4
Ethnic Serbs share in population, 2001	0.9	4.8	11.6
War dummy	1	0.571	-

Source: Croatian Bureau of Statistics, own calculations.

The summary statistics for 539 Croatian municipalities as presented in Table 1 suggest that on average employment decreased from 2001 to 2011 by 9%. However given a widespread population decrease due to falling birth rates and migration, the average change in the employment rate is positive at about 4 percentage points. During the 2000s Croatia was building a large number of new highway sections. About 16% of the municipalities have experienced highway construction in that period. The median municipality has an average distance to the next new highway stretch of about 14 kilometres. The median distance to the next ancient Roman road is somewhat larger (22 km) given that quite a few parts of the Via Pannonia and the Via Flavia cross territory of the neighbouring states of Bosnia and Herzegovina and Slovenia.

Among the municipality characteristics in 2001 we find that about 9% of the municipalities are part of the capital city agglomeration and that some 26% of the municipalities are defined as towns. On average a third of the population has secondary school attainment and more than 5% tertiary school attainment. While the median municipality has no tourist arrivals recorded, the average shows that the number of tourist arrivals is close to three times the population size, which indicates that many Croatian municipalities especially at the coast have strongly specialised in tourism. Also, considering the median municipality, less than 1% of the population

are members of the Serb minority, while on average this share is at about 5%. A number of municipalities in the East and the South of the country are ethnically Serb by the majority. More than 57% of all the municipalities are located in a county that has been experiencing warfare in the 1990s. Pairwise correlation of the potential explanatory variables shows that none of those have a correlation coefficient of more than 70%. Hence, multicollinearity can be ruled out. A scatter-plot analysis hints at a number of potential non-linearities. As a consequence the distance variables are taken in logs and for tertiary school attainment a quadratic function is assumed.

Table 2: Regression results of the effects of highway building in the respective municipality

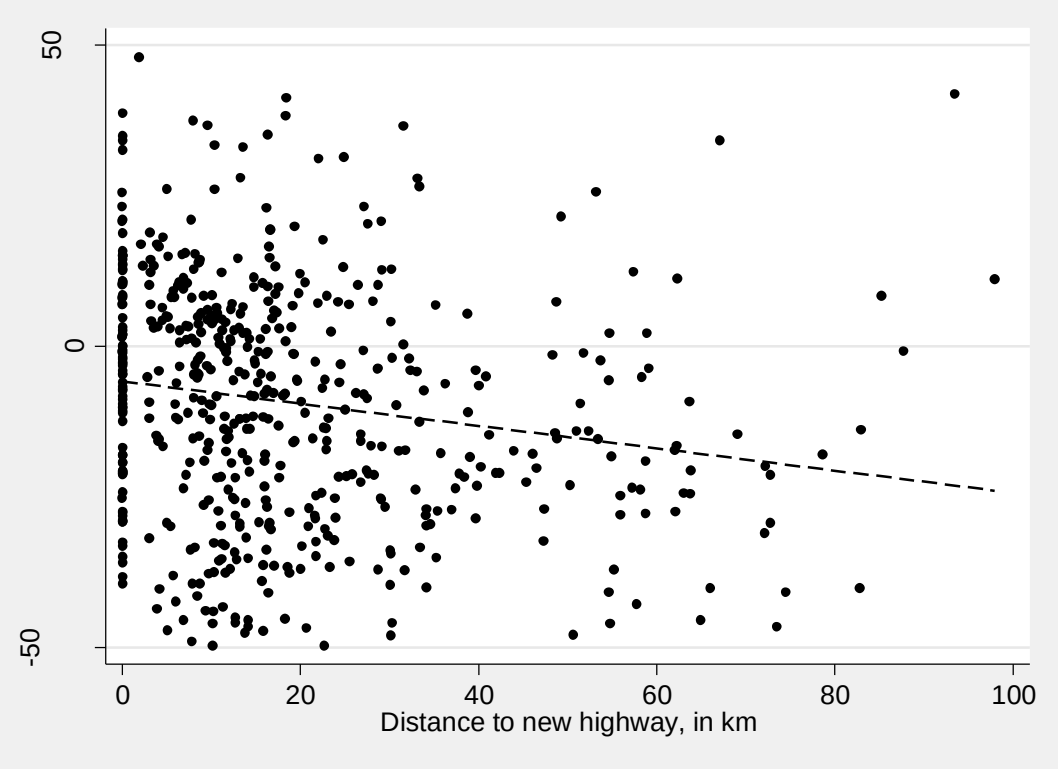
	OLS robust S.E. Employment change in pp. 2001/2011	First stage robust S.E. New highway dummy	Second stage robust S.E. Employment change in pp. 2001/2011
Dependent variable:			
Independent variables:			
New highway dummy	4.656 (1.775)***	-	20.842 (6.932)***
log distance Roman road	-	-0.073 (0.014)***	-
Capital city agglomeration dummy	8.036 (2.179)***	-0.044 (0.055)	8.647 (2.291)***
Town dummy	-6.512 (1.866)***	0.119 (0.041)***	-8.327 (1.984)***
Secondary school attainment share	0.831 (0.191)***	0.004 (0.003)	0.682 (0.208)***
Tertiary school attainment share	3.024 (0.695)***	-0.022 (0.011)**	3.396 (0.710)***
Tertiary school attainment share ^{2}	-0.092 (0.020)***	0.000 (0.000)	-0.098 (0.020)***
Observations	539	539	539
R^2	0.332	0.120	0.246

Note: Intercept not reported; Standard errors in parentheses; ***significant at the 1% level; **significant at the 5% level; *significant at the 10% level.
Source: Croatian Bureau of Statistics, own calculations.

In an initial step equation 1 was estimated with an OLS estimator. Among the control variables the capital city agglomeration and the town dummy was chosen as well as the share of secondary and tertiary school attainment in total population. The goodness of fit of the model is moderate. About a third of the variation in the employment change can be explained by the regressors. Certainly the regression suffers *inter alia* from an omitted-variable bias. However, the number of possible control variables at the municipality level is limited due to data constraints. All the coefficients are estimated in a robust way (due to heteroskedasticity) and significant at the 1% level as can be seen from Table 2.

Our main variable of interest exhibits a coefficient with the expected sign. The interpretation goes as follows. *Ceteris paribus* municipalities that experienced highway construction and the subsequent opening of a highway section during the period of 2001-2011 had almost a 5 percentage point higher increase (or rather a 5 percentage point lower decrease) in employment as compared to the other municipalities. Unsurprisingly the coefficient of the capital city agglomeration dummy appears with a positive sign and of substantial size. Conversely the town dummy coefficient has a negative sign, indicating that the reference group municipalities (i.e. villages) had a better employment record in the analysis period. This might represent the prosperity of affluent suburbs. As expected, a higher initial share of secondary school attainment in total population was positively correlated with the subsequent increase in employment. This variable is most likely a good proxy for a higher initial income level and hence the result might point to increasing income disparities among Croatian municipalities. The results for the initial tertiary school attainment share as well as its squared term display an inverted U-shaped relationship with employment change. Municipalities with average shares of tertiary educated population have experienced a relative increases in employment. However, those with low or very high shares have experienced the opposite. Those cases might hint at municipalities with little additional employment opportunities that are either very remote communities in the country side or on the other hand city centres and saturated tourist communities.

Figure 1: Employment change and distance to the new highway (2001-2011)



Source: Croatian Bureau of Statistics, own calculations.

In order to avoid to a certain extent the possible omitted variable and selection bias as well as simultaneous causality we employ an instrumental variable method. The model applied is a two-stage least-squares (2SLS) model. In a first stage equation 2 is being estimated. It can be shown that indeed the distance to the ancient Roman roads can explain the construction of a new

highway section in the respective municipality in a statistically significant way (see Table 2). Also it seems that new highway construction has been connecting especially towns and remote rural communities given the other two statistically significant variables.

Finally in the second stage we estimate again equation 1 but this time with the predicted new highway dummy results from the first stage. While the coefficients of the control variables remain significant and of similar size as in the OLS regression, the coefficient of the predicted new highway construction dummy is now much larger and still significant (see Table 2). In this specification, municipalities where a highway was built in the period 2001-2011 had a 21 percentage point higher increase (or lower decrease) in employment as compared to the reference group and all the other factors held constant.

Table 3: Regression results of the effects of proximity to a newly built highway

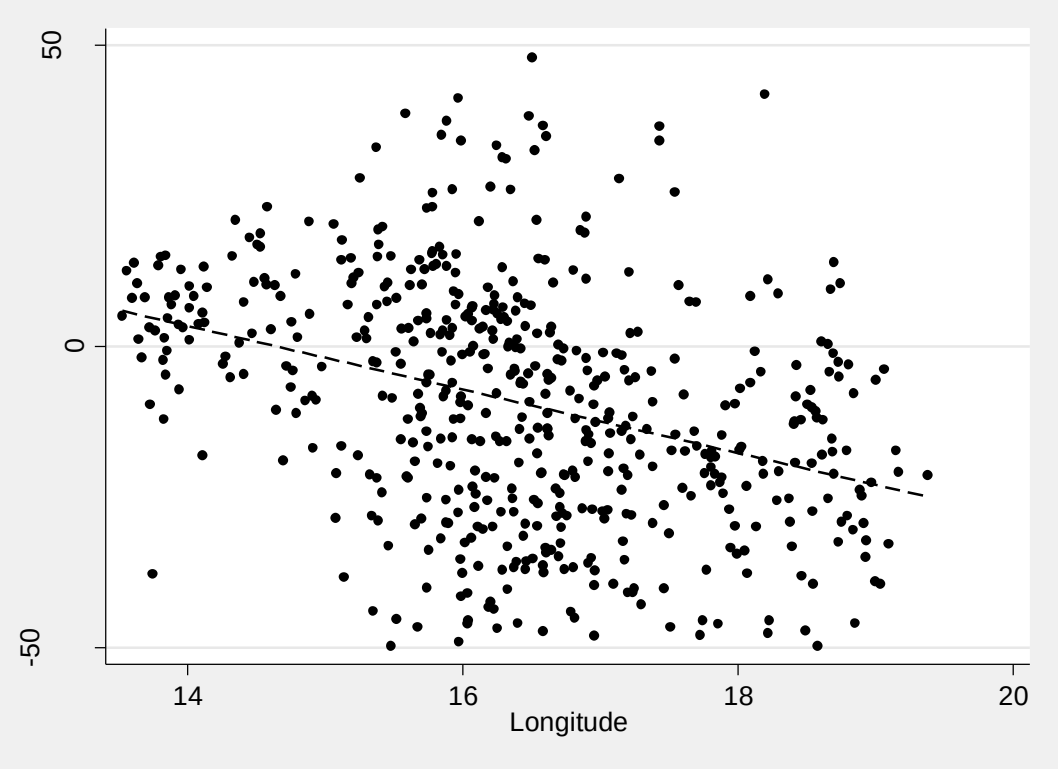
Dependent variable:	OLS robust S.E. Employment change in pp. 2001/2011	First stage robust S.E. log distance new highway	Second stage robust S.E. Employment change in pp. 2001/2011
Independent variables:			
log distance new highway	-0.893 (0.248)***	-	-3.259 (1.095)***
log distance Roman road	-	0.464 (0.080)***	-
Capital city agglomeration dummy	7.337 (2.183)***	-0.545 (0.442)	5.953 (2.500)**
Town dummy	-6.253 (1.851)***	-0.340 (0.268)	-6.949 (1.934)***
Secondary school attainment share	0.785 (0.191)***	-0.068 (0.020)***	0.551 (0.225)**
Tertiary school attainment share	3.117 (0.694)***	0.218 (0.066)***	3.646 (0.730)***
Tertiary school attainment share ^{2}	-0.095 (0.021)***	-0.005 (0.002)***	-0.109 (0.022)***
Observations	539	539	539
R^2	0.336	0.137	0.258

Note: Intercept not reported; Standard errors in parentheses; ***significant at the 1% level; **significant at the 5% level; *significant at the 10% level.
Source: Croatian Bureau of Statistics, own calculations.

In an alternative specification we exchange the new highway dummy variable with the broader measure of the log of the distance to the newly built highway in kilometres. This should allow for the analysis of highway construction effects that include also neighbouring municipalities that might be benefiting from improved transport infrastructure. Surprisingly, results do not change that much at least regarding the coefficients of the control variables (see Table 3). Also the R^2 is only marginally higher. However, the coefficient of our main variable of interest has to be

interpreted in a different way. The result for the coefficient in the second stage has to be read in the following way. *Ceteris paribus* a 10 percent increase in the distance to the new highway yielded a 0.3 percentage point decrease in the change of employment between 2001 and 2011, or the other way around, a 10 percent decrease in the distance to the new highway yielded a 0.3 percentage point increase in the employment change. Figure 1 shows the scatter plot of the employment change and the distance to the new highway in kilometres including the partial regression line. From this it becomes obvious why again the distance data was taken in logs and the standard errors were estimated in a robust way, controlling for heteroskedasticity.

Figure 2: Employment change and longitude (2001-2011, West-East)



Source: Croatian Bureau of Statistics, own calculations.

Given the slightly higher R^2 and the broader interpretation of the new highway effects this is our baseline model. A number of robustness checks have been conducted. In one version we have added additional control variables such as the share of tourist arrivals in total population as well as the share of ethnic Serbs in the population as well as a dummy for counties that were affected by the war in the 1990s. However, none of these coefficients proved to be significant and the other coefficients were not affected. In another version the dependent variable was replaced by the change in the employment share in percentage points. After the exclusion of 22 outliers above or below +/-15% changes in the new dependent variable we receive results that are pretty similar to those in Table 3. A 10% increase in the distance to the new highway is now related to an almost 0.1 percentage point lower employment share. Only the coefficient of the town and the capital agglomeration dummy is now insignificant. Again, in another specification the dependent variable was replaced by the percentage change in the population figure. 23 outliers with rates above and below +/- 50% were exclude. Here all the control variables remain significant in the

2SLS regression, only the significance of the distance to the new highway variable is being reduced to the 10% level. This also happens when the outlier observations are being included.

The only major difference to the results in Table 3 can be achieved when the logs of the latitude and the longitude are being included in the regressions. Here also the coefficient of the town dummy loses its significance. However, more importantly, the coefficient of the log of the distance to the newly built highway is only significant at the 5% level in the OLS regression and finally loses all of its significance in the 2SLS regression. The result is similar in regressions that include county dummies instead of the geographic coordinates. What might be the reason behind this? Figure 2 shows the scatter-plot of the relationship between employment change and the longitude, indicating that the more east a municipality in Croatia is located the less was the growth in employment between 2001 and 2011. Incidentally Western municipalities have the lowest distances to the new sections of the highway network that was built between 2001 and 2011. Hence our variable of interest is clouded by geographical information that also captures a number of site-related factors which we unfortunately cannot account for by standard control variables due to a lack of data at the municipality level. However, given that we want to analyse policy relevant and not seemingly deterministic factors we stick to our baseline results in the last column of Table 3.

Conclusions

This analysis aimed at investigating the effects of construction of modern road transport infrastructure in the Balkans, the economically most backward region of Europe. In a first step the units of observation are Croatian municipalities. In a second step municipality data for Serbia and Bulgaria and possibly other countries from Southeast Europe will be added. Our proxy for economic outcome is the change of employment between the two census years 2001 and 2011. In order to control for possible endogeneity a 2SLS methodology was applied, where the modern highway intervention variable is instrumented by the proximity to the nearest ancient Roman road. This appears to be a perfect instrument given that in the Balkans the major Roman road network was constructed for military purposes mainly. This is also indicated by the name of the longest Roman road that crosses the Balkan Peninsula diagonally – the Via Militaris.

Our results indicate that in a municipality that experienced the construction of a new highway segment, employment was higher by more than 20 percentage points as compared to the average municipality without highway construction. However, also neighbouring municipalities benefited from the opening of new highway sections. A place that is half way closer to a newly built highway stretch recorded more than a 1.5 percentage point higher employment growth.

The results are pretty robust against the inclusion of additional control variables and the use of alternative economic outcome variables as regressands. However all the significance of the main variable of interest is lost, once geolocational information is included in the regression. This is due to the fact that there is *inter alia* a substantial West-East discrepancy in employment growth rates and the fact that most of the new highway construction took place in the more prosperous West of Croatia during the period of analysis. However, disregarding deterministic geographic explanatory variables we can conclude that the construction of modern road transport

infrastructure had not only a positive economic effect on the municipalities directly involved but also on municipalities close to the new highways.

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Appendix

Map 1: Present and ancient Roman roads in the Balkans

Source: Ancient World Mapping Center, Talbert (2000), Deluka et al. (2003), Dzino (2010), Google Maps Engine, own calculations.

Map 2: Present and ancient Roman roads in Bulgaria, Turkey, Greece, Macedonia and Albania

Source: Ancient World Mapping Center, Talbert (2000), Deluka et al. (2003), Dzino (2010), Google Maps Engine, own calculations.

Map 3: Present and ancient Roman roads in Serbia and Montenegro

Source: Ancient World Mapping Center, Talbert (2000), Deluka et al. (2003), Dzino (2010), Google Maps Engine, own calculations.

Map 4: Present and ancient Roman roads in Croatia, Slovenia and Bosnia and Herzegovina

Source: Ancient World Mapping Center, Talbert (2000), Deluka et al. (2003), Dzino (2010), Google Maps Engine, own calculations.