Highways, Structural Change and Urbanization in a Context of Economic Reforms. Evidence on the Effect of Transport Infrastructure in Mexico

Nayeli Salgado*

Vienna University of Economics and Business (WU)

Working paper. This version: June 2017

[Very early draft, please don't quote]

Abstract

This paper provides evidence on the impact of transport infrastructure on local economic development. It compares the effect of being connected to a highway on manufacturing employment and urbanization during the period of Industrialization by Import Substitution (ISI) launched by the Mexican government in 1947. The analysis relied on a novel longitudinal dataset that traces back the municipalities over a 60 year period and the evolution of highways since its construction in 1925. Using difference in difference and instrumental variable estimates, I found that municipalities which gained highways before 1950 had on average 18% more employment in the manufacturing sector and were 70% more dense populated during ISI than municipalities without highways. Additionally, the study shows that later connections de-industrialized and de-urbanized municipalities during ISI. Possible explanations could be agricultural specialization and migration due to lower transaction costs, however, these mechanisms and results required further robustness checks in order to draw appropriate conclusions.

Keywords: Highways, Railroads, Industrialization, Urbanization, Transportation Infrastructure, Structural Change.

*Department of Socioeconomics, Vienna University of Economics and Business. E-mail address: nayeli.salgado@wu.ac.at

1. Introduction

Transport infrastructure is considered a key determinant of economic growth in developing countries, however its contribution is still a matter of debate. Over the last two decades public and international financing of transport infrastructure have increased in both rich and middle income countries expecting to foster gains in welfare. Only in this period, the World Bank has lent more than US$125 billion, nearly half of their total assistance to development. In this logic, investments in transport infrastructure is considered a prominent policy tool to assess within-country integration under the presumption that it spreads the economic activity to peripheral regions (World Bank, 2015).

This paper aims to provide evidence on the effects of transport infrastructure in a poor, rural and predominately agricultural setting during a period of economic reforms that aimed to foster modern development. More specifically, it evaluates the Mexican Highway System (MHS) which was considered one of the foundations of the Industrialization by Import Substitution (ISI) launched by the Mexican government in 1947 (Cardenas1994, Moreno-Brid & Ros-Bosch, 2009). The construction of the MHS started after the end of the Mexican Revolution in 1921. The first stages were planned and financed by the post-revolutionary government. At the beginning the network had political and social purposes but with time they aimed to promote regions economically and integrate the territory (SCT, 1988). By the time the government launched ISI, the network consisted of 22 thousand kilometers., and the next decade the Federal government carried out large amounts of public investment duplicating the network from 45,000 kilometers in 1950 to 213,000 kilometers at the end of 1980 (SCT, 1999).

My empirical analysis exploits the first wave of constructed highways (1930-1950) in order to understand how infrastructure leads the shifts on employment from agriculture towards industry and urbanization. To guide my study, I constructed a unique dataset that allows me to trace back each municipality from the 32 States between during the period of study (1930-1980) and analyze the short and long term structural change and population dynamics of the country. This dataset consists of three pieces of information. The first one is the reconstruction of the decadal development of railroad and highways using current georeferenced, historical maps and archival materials from 1920 until 1980. The second one is a set of novel and comparable indicators that I digitized from censuses prior 1950 and complemented with censuses from 1960-1980 at municipality level. The third one consist of a set of indicators on the initial conditions of unit of analysis from the historical censuses of 1900, 1910 and 1921. These sources provide a longitudinal dataset that reports a measures of stock and distances of infrastructure paired with detailed information on employment by type of industry and sector, socioeconomic and demographic indicators for six decades from 1930 to 1980.

I first use a difference in difference estimation to show that municipalities that were connected to the network before 1950 experienced higher levels of manufacturing employment and substantial relative increases in population during ISI. I also show that these results based on the Ordinary Least Squares (OLS) may be biased if state planners targeted places with higher potential for growth or if the government may have chosen to build highways in areas with low economic potential as a form of redistribution. Although the state plans and the historiography on the evolution of the MHS suggests that the first stages of highways had both components, I show that highways constructed by 1930 were on average more urban and were better connected within their provinces which could be only explained by the fact that they had access to railroads. Although it is not possible to conclude that the post-revolutionary government targeted areas with more prospects to growth, the results suggest that they constructed the first highways in agglomerated municipalities.

To address this concern with the endogeneity of the construction of the MHS I use instrumental variables (IV) to exploit the fact that highways were constructed to connect important endpoints along the shortest route, which meant that several municipalities by virtue of their location along these routes exogenously gained access to the network. I proposed two counterfactuals which exploits the distance from each municipality towards these hypothetical roads. The first instrument depicts the Silver Route used during the Colonial epoch to transport the minerals in the centuries prior to 18^{th} century following similar exercises for other countries (Banerjee et al., 2012). The second instrument consists in an official proposal made by the Ministry of Transportation and Communications that shows the ideal connection of each Province to Mexico City and to the country's borders.

The results with IV show that the OLS estimates were downward biased. Both, the Silver Route and the Plan were positively correlated with highways in the first stage. However, only the later remained significant in the second stage and the coefficients were larger than those reported with simple OLS. The results suggest that municipalities connected to the network between 1930 and 1950 had on average 18% more workers in manufacturing sector and 70% more population by the time of ISI than non-connected municipalities. The differences remain larger and significant when controlling for different levels of urbanization, railroads and initial conditions. Moreover, they show that industrialization and urbanization did not come at the cost of nearby non-connected municipalities. I found that those municipalities located 5 kilometers away from infrastructure had increments of manufacturing employment by only 4%. In a second step, I test whether the second wave of highways constructed between 1950-1980 could have increased the outcomes of interest. Here, I contrast the performance of municipalities that gained highways in the first wave with those that gained highways in the second wave. I found that both industry and population were concentrated in the earlier urban centers. Moreover, I found that municipalities connected during ISI were less urban suggesting that people used the infrastructure to migrate. In these municipalities the share of manufacturing employment was very small.

This paper is related to a growing empirical literature on the evaluation of transport infrastructure structural change, population dynamics and urbanization, as well as the economic history of Mexico. It is related to the contributions that have studied the economic effects of transportation infrastructure such as skill premia in local labor markets (Michaels, 2008), long term GDP effects (Banerjee et al., 2012), gains from trade (Donaldson, 2015; Donaldson & Hornberck, 2015), and city growth (Duranton and Turner, 2012). This study is closer to the core of literature that suggest that transport infrastructure can have short-term effects

(Baum-Snow, 2007; Baum-Snow et al., 2012) on urban development but also long term effects (Berger & Enflo, 2017) and can foster structural change (Yamasaki, 2016). Similar to this literature, my results suggest that transport infrastructure can have short-term substantial effects on industrialization and urbanization. By analyzing Mexico in the early 20th century, I provide a different scenario of whether and how transport infrastructure can lead to inefficient outcomes on local economic development leading to regional inequalities, de-industrialization and impoverishment with the lack of proper policy planning strategies. In this sense, my results appear in a historical context very different from those documented in the industrialized world (Yamasaki, 2016; Berger & Enflo, 2017;) and are more similar to those with a similar institutional and colonial background like those documented for African countries (Jedwad & Moradi, 2015; Jedwab et al, 2015) that show that African cities formed along the Colonial railroads and that cities persist in these locations today.

The remainder of the paper proceeds as follows. Section 2 provides an overview of the history of the evolution of the transportation system within a process of the economic strategies adopted in the country and the data. Section 3 details the empirical strategy, justifies the counterfactuals and their relevance to be used as instruments. Sections 5 discusses the current shortcomings of the paper, proposes some possible causality channels, mentions further lines of research, and concludes.

2. Background and data

2.1 Transport System and the Mexican economic development in the mid-20th century

The 20th century encompasses a period of drastic economic and sociodemographic transition. The first half established the fundaments towards current economic development for Mexico. In the first decades after Mexican Revolution ended in 1921, the post-revolutionary government aimed to balance the political power and the organizational functions of the State. As result it was possible to implement different reforms to modify the strategy of development. In this period, Mexico experienced a transition from the export-oriented profile it had since colonial times towards the inward-oriented production of industrial goods after the Second World War, similar to other Latin American Countries. The development of the MHS can be explained in terms of the logic of this production strategies and distribution of the output.

Prior to highways, there were two types of transportation. The first one was an array of conveyances by bridle paths which was used by the majority of the population. This infrastructure consisted in dirt roads which were the only option for the impoverished peasant population. The second option was railroads, which use was mostly for transportation of raw materials than passengers. Although there is not consensus of whether railroads cause economic growth or underdevelopment, by the end of the century they determined the pattern of urbanization. By 1930 they connected 28 province capitals out of 32, and cities with more than 15,000 and 50,000 inhabitants.

Despite the importance of railroads during the export-agrarian model, the post-revolutionary governments opted for favoring the construction of highways for different reasons. Their construction was seen as part of a bigger redistributive and inclusive strategy that included the land reform, the expropriation of the oil industry and railroads from foreign companies. In this logic, highways were expected to be a more inclusive infrastructure system than railroads.

The construction of the MHS started in 1925. It was planned by the Federal and provincial governments and financed with federal taxes from oil and tobacco consumption. Its main objective was to unify the territory by connecting the administrative capitals of the provinces to Mexico City and the capitals of the municipalities to the latter. It was conceived as a complementary infrastructure in its early stages. However, the network's rapid expansion was possible due to the adoption of the automobile and the development of the oil industry. During the first decade only 1,500 kilometers of highways were constructed, and the network was not unified system. They were placed in the north, center and south without being connected among themselves. Except for the South, they were constructed in parallel to the railroad bounds. The next decades, the network expanded favoring provinces in the Atlantic, the northern border and those with important ports in the Pacific. By 1950, all the provinces were connected to the railroad and highways with similar length of kilometers. Moreover, for the implementation ISI in 1947, the Federal government carried out large amounts of public investment in basic infrastructure to reduce costs of production and supported the industrial production of domestic goods. Hence, this period coincides with the fastest rates of urban growth and population concentration and the consolidation of the first metropolitan areas in the country and the structural transformation of the economy that locates highways as the transport system of industrialization since the network increased 400%, from 22,500 to 213,000 kilometers. Although the high rate of large and fast economic growth with annual rates 7%, by the end of 1980 only two-thirds of the municipalities were connected to the network.

2.2 Data

This paper uses mostly data from the Mexican Department of National Statistics (INEGI) and the Ministry of Communications and Transport (SCT). This dataset consists of three pieces of information. The first one is the reconstruction of the decadal development of railroad and highways since 1920 until 1980. Geo-reference shapes updated to 2015 of railroads and highways were obtained from the Mexican Road Networks System (RNC) project. This data provides detailed information about the highways but not about when they were constructed. I determined the historical evolution of the networks at the end of each decade based on historical maps and records from the SCT and National Historical Archive (AGN).

The second piece of evidence is a novel set of indicators that I digitalized at municipality level for censuses prior to 1950 and complemented with the censuses of 1960-1980. This dataset contains detailed information on employment by type of industry and sector, and comparable indicators of the population dynamics of each municipality. At this point I have a unique longitudinal dataset that reports stock and distances of infrastructure for highways and railroads paired with detailed socioeconomic and demographic indicators for all the municipalities in Mexico over the 60 year period. The third piece of information comes from the historical censuses of 1900, 1910 and 1921 from which I take a set of indicators on the initial conditions prior the construction of the MHS.

During the period of study nearly one-quarter of the municipalities changed and their respective administrative borders. To facilitate my analysis, I constructed constant spatial units over time using as reference the municipalities in 1930. The aggregation was done using as the catalogs reported in the censuses and the municipality historical dictionary released by the National Institute for the Municipality Development (INAFED).

Due to comparability and data limitations the municipalities of the province Oaxaca were aggregated at district level. The province consists nowadays in 570 municipalities, but INEGI aggregates them in 30 indigenous districts that are classified by their cultural identity and geographic location. This procedure makes the comparison of the territory over time feasible and facilities the analysis since many of these municipalities are have less than 5000 inhabitants according to the current census of 2015.

3. Empirical Strategy

3.1 Difference in difference

To examine the impact of the first highways constructed before ISI on industrial employment and urbanization, I compare municipalities that gained access or connected to the network before ISI to a control group of municipalities that did not using a difference-in-differences strategy. Using data for the years 1930-1980, I estimate equation (1) in which the outcomes of interest (Y_{ipt}) are the share of employment in manufacturing industry (M_{ipt}) and population density (P_{ipt}) in each the municipality *i*, located in the province *j*, observed in the year *t*:

$$\boldsymbol{In(Y_{ipt}) = \alpha_i + \lambda_i + (\lambda_i \times \gamma_{pt}) + \delta(Connect_i \times Post_t) + Z'_{it}X_i + \varepsilon_{ipt}} \quad \textbf{(1)}$$

The treatment indicator consists of two components, both are dummy variables. The measure of highways that I use is $Connect_i$ which takes the value of one if all the counties with access or connected to the network by the time ISI was launched (1947). It has been constructed using a 10 km buffer around the highway and takes the value of 1 when any part of the municipality is coverage by the buffer between 1930-1950 and 0 otherwise. $Post_t$ takes the value of 1 when ISI was implemented (e.g. 1960, 1970 and 1980) and 0 otherwise. Additionally, I include municipality fixed effects (α_i) that capture time invariant factors potentially correlated with being connected to the network; year fixed effects (λ_i) to capture those factors causing industrialization and urbanization in this period and an interaction between province-by-period fixed effects $(\lambda_i \times \gamma_{pt})$ to account for the fact that highways were planned and financed by the provinces.

X_{it} is a vector of municipality-specific control variables. The error term ε_{it} captures any remaining unobserved determinants or measurement error in Y_{it}. Since standard errors could be correlated across counties that were connected to a similar part of the network during a similar period, I cluster them at the provincial-level in all specifications.

For measuring the impact of highways on manufacturing I contrast the previous baseline without controls with three additional specifications. The first one including different levels of urbanization to account by the fact manufacturing would be associated to the urbanization and population available in the municipality to get involved in the sector. The second specification controls for additional infrastructure measure by the distance of the capital of each municipality towards the closest infrastructure (e.g. railroad), and the last one include a set of observable controls for pre-existing county level of population density by 1921 and the annual rate of growth of the population between 1921 and 1930.

To measure the effect of highways on urbanization (i.e. population density) I replace the urbanization specification for another that shows the structural employment of each municipality by including the share of employment on manufacturing, trade and services. In all the specifications I exclude Mexico City. There is a general consensus that ISI promoted the concentration of economic activity in the metropolitan area around Mexico City and the literature shows that this area is unlike other regions due to the huge urban agglomeration of one of the world's largest cities. In terms of stock of highways, the only municipality with highways within Mexico City is Milpa Alta while the rest of the municipalities have high-speed streets within the city.

3.2 IV Strategy: Counterfactuals

The MHS was not exogenously place, during the first stages of its construction it followed the structure distribution of the railroad, specifically, the concentric structure towards Mexico City favoring the north towards United States. In order to avoid the problem with reverse causation, I complement my difference-in-differences specification with an instrumental variable (IV). I constructed two instruments, all computed using ArcGIS and Conical Projections. The main source of plausibly exogenous variation for access to infrastructure is the nearest distance from capital of the municipality to either the Silver Route or the line proposed by the SCT.

The first counterfactual depicts the Historical Silver Route at the last third of the 18th century (Annex, Figures 2 and 3). This strategy follows the approach used by Barnajee et al. (2012) with the Silk Route in China. In the case of Mexico, the Silver Route connected Mexico City to the principal provinces in the territory. Therefore, this counterfactual shows the principal routes that Spaniards followed to mobilize the minerals during the 18th century. It connects the capital two the main ports: Veracruz in the Atlantic and Acapulco in the Pacific. In the north this route connected to the mining towns, the *obrajes* (textiles centers) and the haciendas. This path crossed the center of the country towards Santa Fe, now United States. To the southwest, the route connected areas with higher concentrations of indigenous populations like Oaxaca and Chiapas and it connected to The Viceroyalty of Guatemala. The line is continued past the city until it hits a natural barrier (e.g coast line), or a border to another country.

The second counterfactual consists in an official proposal made by the Ministry of Transportation and Communications that depicts the ideal connections between Mexico City with its 31 Province Capitals, and the north and south borders. According to this plan, the ideal network should connect all the provincial capitals with Mexico (Figure 3).

In practice, I use these instruments to predict highways connections in place before 1950, corresponding to the following first (2) and second stage (3):

$$R_{it} = \zeta_i + \varphi_t + (\theta_i \times \rho_{pt}) + \psi(Instrument_i^z \times Post_t) + Z_{it}' X_i + \vartheta_{ipt} \qquad (2)$$

$$In(Y_{ipt}) = \alpha_i + \lambda_i + (\lambda_i \times \gamma_{pt}) + \sigma(\widehat{Highways}_{it}) + Z_{it}' X_i + \varepsilon_{ipt} \qquad (3)$$

Where $Instrument_i^z$ denotes one of the IV, either the Silver Route or the Plan that are interacted with a dummy taking the value of 1 for the year 1950 and 0 for other periods, used to predict highways connections ($\widehat{Highways}_{it}$) in the second stage. ζ_i and α_i are municipality fixed effects. And φ_t and λ_t are year fixed effects respectively. The components of $\theta_i \times \rho_{pt}$ or $\lambda_i \times \gamma_{pt}$ represents the interaction between province fixed effects with year fixed effects. Z_{it} is a vector of control variables.

Identification of the impact of an early rail connection (δ) in equation (3) requires that the instruments do not affect manufacturing employment or population density through channels other than highways actually constructed. In the following paragraph I report and discus the baseline estimation results.

4. Main results

4.1 Summary statistics

Historical accounts suggest that the policy makers originally had the intention to connect the provincial capitals to Mexico City. However, the first stages of the development of the highway system complemented the railroad network and later connections had two purposes: provide more infrastructure to places with growth prospects, and to integrate isolated regions. This would imply differences in terms of the municipality's outcomes for municipalities that gained access to the network relative to non-connected municipalities. Table 1, panel A shows before the first highways were constructed, municipalities connected to the railroad network had bigger and growing populations. On average, the difference was 4 million and it was statistically significant. Panel B, shows that the municipalities that gained highways by 1930 conditional of having the infrastructure had not very different characteristics than those larger populations. On average these municipalities were more urbanized and closer to the provincial capital than non-targeted municipalities. On the contrary, Panel C shows that the municipalities that gained highways but did not have railroads had on average, smaller populations, larger population densities; they were closer their provincial capitals and had more employment in non-agriculture activities. Finally, panel D, shows that there were municipalities without railroads that were connected to the network. These last group was larger more urban and had important shares of its labor force in involved in the industrial sector.

Table 1. Pre-highway differences between municipalities with and without access

	Baseline sample		
	Infrastructure or connected (1)	Without infrastructure (2)	Diff (1)-(3) (3)
Panel A. Railroad era			
Total population 1921	11.867	6.901	4.97 ***
Population density 1921	28.110	21.433	6.68 ***
Population growth 1921-1930 (%)	1.313	0.900	0.41 ***
Panel B. The first highways decade conditional of having railraod (=1)			
Total population 1930	14.723	12.911	1.81
Population density 1930	61.326	25.900	35.43 ***
Distance to the province capital	40.256	79.605	-39.35 ***
Employment structure, 1930 (% of the local labor force)			
Agriculture	78.871	81.466	-2.59
Industry	9.166	8.000	1.17
Trade	6.507	4.474	2.03 ***
Services	1.166	0.820	0.35 ***
Non-agriculture	20.669	18.193	2.48
Panel C. The first highways decade conditional of having railraod (=0)			
Total population 1930	5.238	7.038	-1.80
Population density 1930	23.117	21.377	1.74
Distance to the province capital	51.903	82.638	-30.74 ***
Employment structure, 1930 (% of the local labor force)			
Agriculture	86.936	88.247	-1.31
Industry	6.316	5.723	0.59
Trade	4.338	2.939	1.40 **
Services	1.214	0.555	0.66 ***
Non-agriculture	13.064	11.533	1.53
Panel D. Municipalities conditional of having infrastructure (=0)			
Total population 1930	14.723	7.038	7.68 ***
Population density 1930	61.326	21.377	39.95 ***
Distance to the province capital	40.256	82.638	-42.38 ***
Employment structure, 1930 (% of the local labor force)			
Agriculture	78.871	88.247	-9.38 ***
Industry	9.166	5.723	3.44 ***
Trade	6.507	2.939	3.57 ***
Services	1.166	0.555	0.61 ***
Non-agriculture	20.669	11.533	9.14 ***

4.2 Effect of the first highways on manufacturing employment and population before ISI

Table 2 presents my estimations from equation (1), showing that municipalities which gained highways prior 1950 experienced substantial and statistical significant increases in manufacturing employment during ISI compared to those municipalities that were not connected to the network. The baseline estimation in column (1) suggests that municipalities with access to highways prior ISI had on average 18% more employment in this sector than municipalities without highways. Columns (2)-(3) shows that when controlling for different types of urbanization and distance to the closest infrastructure such as railroads, the effect of highway on manufacturing employment is smaller but still significant. Colum (4) controls for the initial conditions of population, showing that municipalities which populations were annually growing faster between 1921-1930 had more manufacturing employment during ISI than those which were not connected.

Table 2. Effect of the first highways on manufacturing employment during ISI: OLS estimates

	OLS ESTIMATES			
	Baseline	Urbanization	Infrastructure	Initial conditions
	(1)	(2)	(3)	(4)
Highways 1st stage x Post	0.180***	0.168***	0.176***	0.186***
Levels of urbanization				
More than 15 thousand inhab.		0.153***		
Between 15 and 50 thousand inhab.		0.155**		
Between 50 and 100 thousand inhab.		-0.0278		
Between 100 and 250 thousand inhab.		-0.141		
Between 250 and 500 thousand inhab.		-0.611***		
Between 500 and 1 million inhab.		-0.525**		
More than 1 million inhab.		-0.148***		
Total population (ln)		0.203***		
Distance to infrastructure (ln)			0.0131**	
Population density 1921 (ln)				0.00226
Pop. Growth, 1921-1930 (%)				-0.308***
Constant	1.719***	1.341***	1.648***	2.164***
Municipality FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Province x Year FE	Yes	Yes	Yes	Yes
Observations	5,762	5,759	5,747	4,964
R-squared	0.289	0.307	0.289	0.306
Number of mun	1,037	1,037	1,034	877

Statistical significance based on standard errors clustered at municipality level is denoted by : *** p<0.01, ** p<0.05, * p<0.1

If policy planners targeted areas with potential to growth the OLS coefficients could be bias ex-ante. Estimating specification (1) by OLS would imply the assumption that county connections between nodal cities were randomly assigned within provinces. Given the policy setting of the MHS, this assumption would be strong. The OLS results show that planners targeted politically important and economically prosperous regions on the way between the network's nodal cities which were already important before the construction of the network. This concern is supported by descriptive statistics reported in Table 1. Municipalities connected to the network prior 1950 were on average larger, richer, more urbanized, and industrialized than non-connected peripheral municipalities.

Table 3 columns reports 2SLS estimates obtained using the *Silver Route,* colums (1)-(4) and the *Plan SCT* (5)-(8) proposed by the Ministry of Communications. First, I analyze the direction of the bias of OLS and the IV estimates. In both cases the instrument is positive and significant in the first stage (Panel A). Panel B shows the second stage. The estimations using IV are consistently larger showing that the effect being connected to the network was downward biased by OLS. The coefficients remain positive implying that earlier connections to the network had larger effects on becoming manufacturing employment but not significant when using the Silver Route as instrument. Besides, the coefficients from the Plan are twice larger those obtained by OLS or using the Silver Route. Although one might expect that the Silver Route could help predict the construction of highways this result show that municipalities that were connected before 1950 do not necessarily coincide with those municipalities that in previous centuries were involved the mining industry.

Table 3. Effect of the first highways on manufacturing employment during ISI: IV estimates

INSTRUMENT (IV):	*SILVER ROUTE*				*PLAN SCT*			
	Baseline	Urbanization	Infrastructure	Initial conditions	Baseline	Urbanization	Infrastructure	Initial conditions
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
				Panel A. First stage (connected before ISI)				
Instrument $(L_i) \times Post_t$	0.1064***	0.0930***	0.0059	0.1155***	0.1199***	0.1036***	0.1191***	0.1167**
				Panel B. Second stage (outcome: ln manufacturing employment share)				
Highways 1st stage x Post	0.194	0.241	0.181	0.140	0.304**	0.379**	0.281**	0.277**
Levels of urbanization								
More than 15 thousand inhab.		0.150***				0.146***		
Between 15 and 50 thousand inhab.		0.139*				0.112		
Between 50 and 100 thousand inhab		-0.0564				-0.108		
Between 100 and 250 thousand inha		-0.180				-0.251		
Between 250 and 500 thousand inha		-0.656***				-0.738***		
Between 500 and 1 million inhab.		-0.569**				-0.650**		
More than 1 million inhab.		-0.160***				-0.184***		
Total population (ln)		0.199***				0.190***		
Distance to infrastructure (ln)			0.0130**				0.0122**	
Population density 1921 (ln)				-0.000149				0.00711
Pop. Growth, 1921-1930 (%)				-0.310***				-0.303***
Constant	1.792***	0.987***	1.796***	2.223***	1.805***	1.418***	1.745***	2.090***
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province x Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	5,747	5,744	5,747	4,949	5,747	5,744	5,747	4,949
Number of municipalities	1,034	1,034	1,034	874	1,034	1,034	1,034	874

Statistical significance based on standard errors clustered at municipality level is denoted by : *** p<0.01, ** p<0.05, * p<0.1

Table (4)-(5) presents the effects of being connected to the network on population density. Only during 1940-1950, the urban population in the country grew 6% annually, experiencing the fastest urbanization due to the massive mobilization from rural areas to the cities and the natural growth of the population that were attracted by demand of labor needed by the new industry. Table (4) shows the OLS estimates of being connected to the network before 1950 on population growth during ISI. At difference to the previous specifications this model controls by the employment structure of the municipalities, column (2) instead of the levels of urbanization. The results show municipalities that were earlier connected to the network were also larger during ISI. On average, municipalities connected to the network had 20% higher population densities than those without highways. The effect is similar when controlling for distance to railroads or initial urbanization and population growth.

Table 4. Effect of highways the first highways on population density during ISI: OLS estimates

	OLS ESTIMATES			
	Baseline	Linkages	Infrastructure	Initial conditions
	(1)	(2)	(3)	(4)
Highways 1st stage x Post	0.222***	0.204***	0.221***	0.237***
Employment structure (ln)				
Manufacturing		0.0466***		
Trade		0.0414*		
Services		0.0261*		
Distance to infrastructure (ln)			0.00329	
Population density 1921 (ln)				-0.0886***
Pop. Growth, 1921-1930 (%)				0.0679***
Constant	2.559***	2.422***	2.531***	4.518***
Municipality FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Province x Year FE	Yes	Yes	Yes	Yes
Observations	5,696	5,523	5,681	4,979
R-squared	0.579	0.578	0.578	0.542
Number of municipalities	1,016	1,016	1,013	877

Statistical significance based on standard errors clustered at municipality level is denoted by : *** p<0.01, ** p<0.05, * p<0.1

One of the main concerns with the construction of highways and infrastructure is that they could have been constructed where population was concentrated. Table 5, panel A shows both instruments are significant. This could suggest that in this case the Silver Route is capturing the colonial population settlements and PLAN SCT other aspects of the population dynamics. Panel B, shows that the first wave of highways increased urbanization during the ISI by around 70% regardless of the availability of railroads and the initial levels or urbanization of these municipalities.

Table 5. Effect of the first highways on population density during ISI: IV estimates

INSTRUMENT (IV):	*SILVER ROUTE*				*PLAN SCT*			
	Baseline	Linkanges	Infrastructure	Initial conditions	Baseline	Linkanges	Infrastructure	Initial conditions
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
			Panel A. First stage (connected before ISI)					
Instrument (L_i) *x Post*$_t$	0.1056***	0.1056***	0.1051***	0.1153***	0.1196***	0.1201***	0.1189***	0.1163***
			Panel B. Second stage (outcome:ln population density)					
Highways 1st stage x Post	0.667***	0.671***	0.667***	0.704***	0.707***	0.715***	0.708***	0.781***
Employment structure (ln)								
Manufacturing		0.0345**				0.0334**		
Trade		0.0255				0.0240		
Services		0.0168				0.0159		
Distance to infrastructure (ln)			-0.000190				-0.000512	
Population density 1921 (ln)				-0.0638***				-0.0597***
Pop. Growth, 1921-1930 (%)				0.0919***				0.0959***
Constant	2.627***	2.674***	2.595***	3.968***	2.651***	2.648***	2.645***	3.884***
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province x Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	5,681	5,508	5,681	4,964	5,681	5,508	5,681	4,964
Number of municipalities	1013	1,013	1,013	874	1,013	1,013	1,013	874

Statistical significance based on standard errors clustered at municipality level is denoted by : *** p<0.01, ** p<0.05, * p<0.1

4.3 Spillovers in municipalities with infrastructure endowment

A central issue is to understand whether transport infrastructure leads to growth or mainly causes economic activity to be reallocated across locations. While estimates presented above suggest substantial relative gains for connected municipalities, growth may be driven by relocation from nearby non-connected municipalities. In the presence of such general equilibrium effects, estimated relative changes in manufacturing employment and population would overstate the impact of highways connections.

To distinguish between growth and reorganization, I compare the outcomes of interest (e.g. manufacturing employment and population density) conditional to the distance from the capital of each municipality to the closest infrastructure, either railroad or highways.

Table 6 presents results from estimating equation (1) where I gradually change the control group to consist in an additional treatment indicator that takes the value of 1 when a municipality is connected to the network at varying distances. For example, column 2 compares municipalities that gained highways before 1950 to non-connected municipalities located at least 5km from the network. In each column, I shift the cut off to different distances. Columns (1)-(5) shows that the treatment effect decreases as distance to infrastructure increases. In other words, employment in manufacturing and population density decreases the longest the municipality is from having access to transport infrastructure which would imply that municipalities within 5 kilometers to the network have shares of population in the manufacturing sector but not after that distance. Column (5) suggests that after 100 km there are urban municipalities where manufacturing employment is large although not having infrastructure.

Table 6. Did municipalities that were connected before 1950 grow at the expense of others?

Control group	**>5 km**	**>10 km**	**>20 km**	**>50 km**	**>100 km**
	(1)	(2)	(3)	(4)	(5)
Panel A. Baseline sample					
Manufacturing employment (ln)	0.0438	-0.0685	-0.457***	-0.211**	0.300
Population density (ln)	-0.0932*	-0.146*	-0.222**	0.924***	0.197***
Panel B. With controls					
Manufacturing employment (ln)	0.0385	-0.0450	-0.356***	-0.333***	0.270
Population density (ln)	-0.0937*	-0.144*	-0.177*	0.891***	0.186***
Municipality FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Province x Year FE	Yes	Yes	Yes	Yes	Yes

Statistical significance based on standard errors clustered at municipality level is denoted by : *** p<0.01, ** p<0.05, * p<0.1

4.4 Did later highways matter?

Between 1960 and 1980, the highway network expanded from 45, 000 to 213,000 km, eventually connected two-thirds of the total municipalities. Did highways constructed before ISI have similar effects on manufacturing employment and population density as those connected to the network during ISI?

Table 7 presents results from estimating equation (1) adding an additional treatment indicator that take the value of 1 if a municipality connected network after 1950 conditional of being connected before 1950. Colum 1 shows that municipalities connected to the network before 1950 had on average 53% increase in manufacturing employment than other municipalities during ISI. In contrast, municipalities that were connected to the network during ISI lost workers in manufacturing industry. However, this estimates are not significant except when controlling for distance to railroads. Table 7 also suggests that municipalities that gained highways during ISI might have de-industrialized or specialized in agriculture since being connected is decreasing the percentage of workers in manufacturing. This is similar to population suggesting that these second wave of highway might have contributed to mobilize people by allowing them to migrate.

Table 7. Comparing the first wave to later rail connections, 1930-1980

	Baseline	Urbanization /Linkages	Infrastructure	Initial conditions	IV: Plan
	(1)	(2)	(3)	(4)	(5)
Manufacturing employment					
Municipalities connected before ISI	0.533***	0.290***	0.472***	0.429***	1.746***
Municipalities connected during ISI	-0.0582	-0.0546	-0.0905*	-0.0376	-3.524***
Population density					
Municipalities connected before ISI	0.645***	0.614***	0.646***	0.521***	2.307***
Municipalities connected during ISI	-0.350***	-0.349***	-0.353***	-0.254***	-4.791***
Municipality FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Province x Year FE	Yes	Yes	Yes	Yes	Yes
Observations	3,100	3,100	3,091	2,629	3,091
Number of mun	1,037	1,037	1,034	877	1,034

Statistical significance based on standard errors clustered at municipality level is denoted by : *** p<0.01, ** p<0.05, * p<0.1

5 Conclusions

The paper analyzed the impact of the first highways constructed at the beginning of the 20th century on local economic development during the implementation of the industrialization by import substitution showing that that municipalities which gained highways before 1950 had higher shares of employment in manufacturing and population densities during ISI. Furthermore, the study provides insights to understand the failure of the inward production policy by pointing out inefficiencies in the distribution of transport infrastructure. The results evidenced that the first highways reinforced the concentration of industry and urban patterns which was already shaped by railroads in the previous century. This study also suggest that the distribution of highways during ISI could have not being planned since municipalities that were connected during this period experienced a de-industrialization and de-urbanization. Causality and channels of persistence need to be examine in further versions of this paper.

References

Atack, J., et al. (2010). "Did Railroads Induce or Follow Economic Growth? Urbanization and Population Growth in the American Midwest, 1850-60," Social Science History, 34(2), pp. 171-197.

Banerjee,A. Duflo, E. and Qian, N. (2012). On the Road: Access to Transportation Infrastructure and Economic Growth in China, MIT Department of Economics Working Paper no. 12-06.

Berger, T., & Enflo, K. (2017), "Locomotives of local growth: The short- and long-term impact of railroads in Sweden", Journal of Urban Economics (forthcoming, doi:10.1016/j.jue.2015.09.001)

Chandra, A. & Thompson, E. (2000). "Does public infrastructure affect economic activity?: Evidence from the rural interstate highway system" Regional Science and Urban Economics 30(4), 2000, pp. 457–490.

Chias, L., Reséndiz, H. & García, J. (2010). El sistema carretero como articulador de las ciudades, in Garza. G. & Schteingart, M. (coord.) (2010), *Los grandes problemas de México: Desarrollo urbano y regional*, vol. 2, El Colegio de México, México, D.F.

Chiquiar, D. (2004). Why Mexico's regional income convergence broke down?, *Journal of Development Economic*, no.77, pp.257-275.

Calderon, Moral-Benito & Serven (2011) "Is infrastructure capital productive? A dynamic heterogeneous approach," Journal of Applied Econometrics, 30(2), pp. 177-198.

Corral, L. & Reardon, T. (2001). "Rural nonfarm incomes in Nicaragua", World Development 29(3), pp. 427-442.

Donaldson, D. (2017). "Railroads of the Raj: Estimating the Impact of Transportation Infrastructure," American Economic Review (forthcoming).

Duran-Fernandez, R. & Santos, G. (2014). Road infrastructure spillovers on the manufacturing sector in Mexico, Regional Development and Transport Infrastructure in Mexico, vol.46, pp. 17–29.

Faber, B. (2014). Trade Integration, Market Size, and Industrialization: Evidence form China's National Trunk Highway System, *Review of Economic Studies* vol. 81 no, 3, pp. 1046-1070.

Fogel, R. (1964). Railroads and American economic growth: essays in econometric history, Baltimore, Johns Hopkins Press.

____________ (1962). A Quantitative Approach to the Study of Railroads in American Economic Growth: A Report of Some Preliminary Findings, *Journal of Economic History*, vol.22, no. 2, pp.163–197.

Fishlow, A. (1965). American railroads and the transformation of the antebellum economy, Cambridge, Harvard University Press.

Fuentes, N., & Mendoza, J. (2003). Infraestructura pública y convergencia regional en México, 1980-1998, *Comercio Exterior*, vol.53, no.2, pp.178-187.

German, V. & Barajas, H. (2014). The Nexus between Infrastructure Investment and Economic Growth in the Mexican Urban Areas, *Modern Economy*, vol.5, pp. 1208-1220.

Gonzalez-Navarro, M. & Quintana-Domeque, C. (2012). The Impact of Paving Roads in Mexico, Working paper. Available Online: http://www.povertyactionlab.org/evaluation/impact-paving-roads-mexico [Accessed 24 March 2016]

Hornung, E. (2015). "Railroads and growth in Prussia", Journal of the European Economic Association 13(4), pp. 699-736.

Aspe, P. (1993). Economic Transformation: The Mexican Way, Cambridge, Mass: MIT Press.
Faber, B. (2014). Trade Integration, Market Size, and Industrialization: Evidence form China's National Trunk Highway System, *Review of Economic Studies* vol. 81 no, 3, pp. 1046-1070.
Feltenstein, A. & Ha, J. (1995). The role of infrastructure in Mexican Economic Reform, *World Bank Economic Review*, vol.9, no.2, pp.287-304
Fishlow, A. (1965). American railroads and the transformation of the antebellum economy, Cambridge, Harvard University Press.

German, V. & Barajas, H. (2014). The Nexus between Infrastructure Investment and Economic Growth in the Mexican Urban Areas, *Modern Economy*, vol.5, pp. 1208-1220.

Lahr, M. Duran, R. & Varughese, A. (2005). Estimating the Impact of Highways on Average Travel Velocities and Market Size, Center for Urban Policy Research, Urban/Regional, EconWPA.

Michaels, G. (2008). The Effect of Trade on the Demand for Skill: Evidence from the Interstate Highway System, *The Review of Economics and Statistics*, vol. 90, no.4, pp. 683–701.

Noriega, A. & Fontela, M.(2005). Public Infrastructure and Economic Growth, UG-CIDE.

Ortiz, S. (1974). Caminos y transportes mexicanos al comenzar el siglo XIX, Secretaría de Comunicaciones y Transportes. Available Online: http://revistas.bancomext.gob.mx/rce/magazines/510/6/RCE10.pdf [Accessed 8 February 2015]

World Bank (2011). Transformation through infrastructure. Washington, DC: World Bank. Available Online: http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/EXTINFRA/0,,contentMDK:23117980~menuPK:8497224~pagePK:64168445~piPK:64168309~theSitePK:8430730,00.html [Accessed 8 April 2015]

____________(1994). Infrastructure for development. World Development Report 1994. New York: Oxford University Press.

Wooldridge, J. (2012). Introductory Econometrics: A Modern Approach, South-Western College Pub, 5th edition.

Kwon, E. (2000). Infrastructure, growth, and poverty reduction in Indonesia: A cross-sectional analysis. Manila: Asian Development Bank.

Lahr, M.L., Duran, R. & Varughese, A. (2005). Estimating the Impact of Highways on Average Travel Velocities and Market Size. Rutgers University Center for Urban Policy Research.

Mallick & Carayannis (1994). Regional Economic Convergence in Mexico: An Analysis by Industry, Growth and Change, Vol. 25, Issue 3, pages 325–334.

Michaels, G. (2008). The Effect of Trade on the Demand for Skill: Evidence from the Interstate Highway System, *The Review of Economics and Statistics*, vol. 90, no.4, pp. 683–701.

Annex

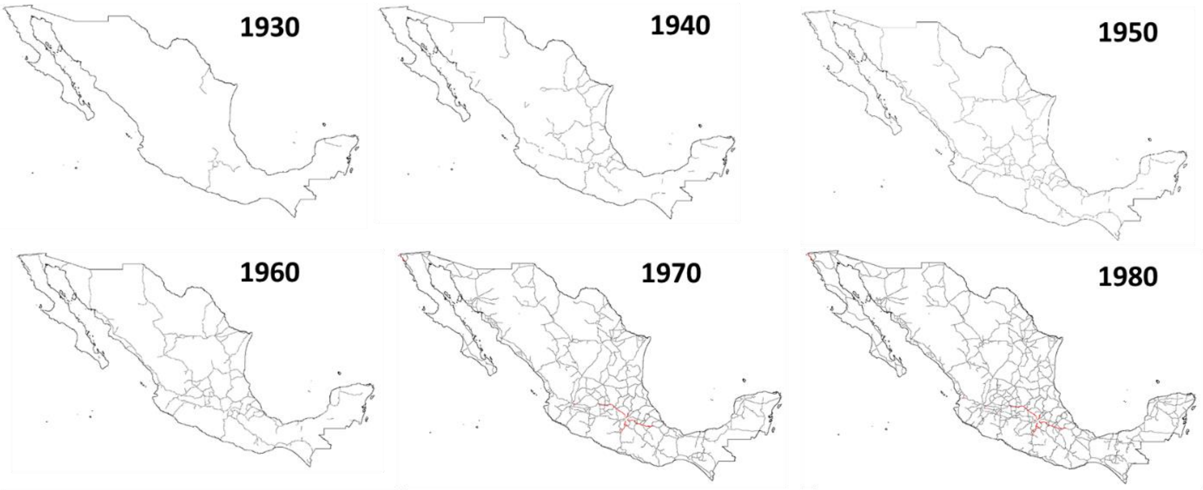

Figure 1. Evolution of the Mexican Highway System 1930-1980: These figures display the decadal evolution of the highway network (highways depicted with thick lines) during the 20th century. This figure is based on a GIS database. Source: Author's elaboration based on official publications. See Appendix for details.

Figure 2. Railroad and Highway Network in 1930: The red lines depicts the railroad network and the blue lines depicts the highways constructed by 1930.

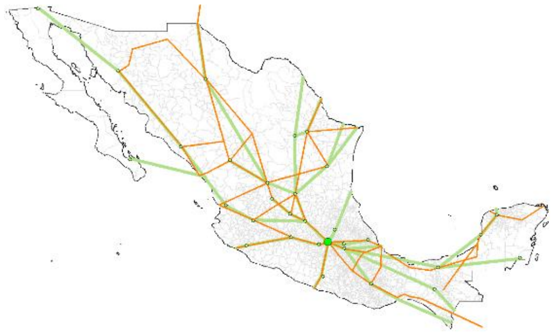

Figure 3. Counterfactuals: The network in orange color depicts Silver Route and bridle roads in the last third of the 18th century. The network in green color depicts lines ideal connections proposed by the Minister of Communications to connect Mexico City with the provincial capitals.