Roads and the Geography of Economic Activities in Mexico

Brian Blankespoor
Development Data Group, The World Bank

Théophile Bougna
Development Research Group (DIME), The World Bank

Rafael Garduno-Rivera
Centro de Investigación y Docencia Económicas, Mexico

Harris Selod
Development Research Group, The World Bank

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Motivation and objectives

Transport infrastructure and economic growth

Transport investments can stimulate growth (Calderon et al. 2009).

Effects could be large in Latin America (given the "infrastructure gap").

See recent surveys (roads and railways) by Redding and Turner (2015), Berg et al. (2017), and Bougna et al. (2017).

Two issues in the literature:

- **Indirect focus on specialization although crucial in models**

- **Cross-sectional empirical studies**

What we do

We investigate the causal impact of transport infrastructure (**roads**) on **local employment** and **specialization**. Specifically, we...

- ...make use of historical and geo-referenced data (1986-2014);
- ...consider heterogeneity of impact along spatial lines (more developed North closer to US-Mexico border which receives FDI *Vs.* the less developed South) and time lines (before/after NAFTA);
- ...address potential endogeneity concerns.

Preview of the Main results

A 10% increase in (domestic) **market access** results in a 2% increase in total employment, and a 3% to 7% increase in specialization.

A 10% increase in (domestic) **market potential** results in a 2 to 3% increase in total employment.

We also find positive effects when regressing on **infrastructure only** variables.

There are **heterogeneous effects** across **regions** and **sectors**.

Lower travel cost/time to the US (resp. to ports) stimulates (resp. depresses) **employment** and **specialization**; the effects are **magnified after** NAFTA.

Outline

[1] Data, measures, and stylized facts: roads / employment / specialization

[2] Methodology

[3] Results

[4] Conclusion and Policy Implications

Data, measures, and stylized facts

Data

[1] Economic data

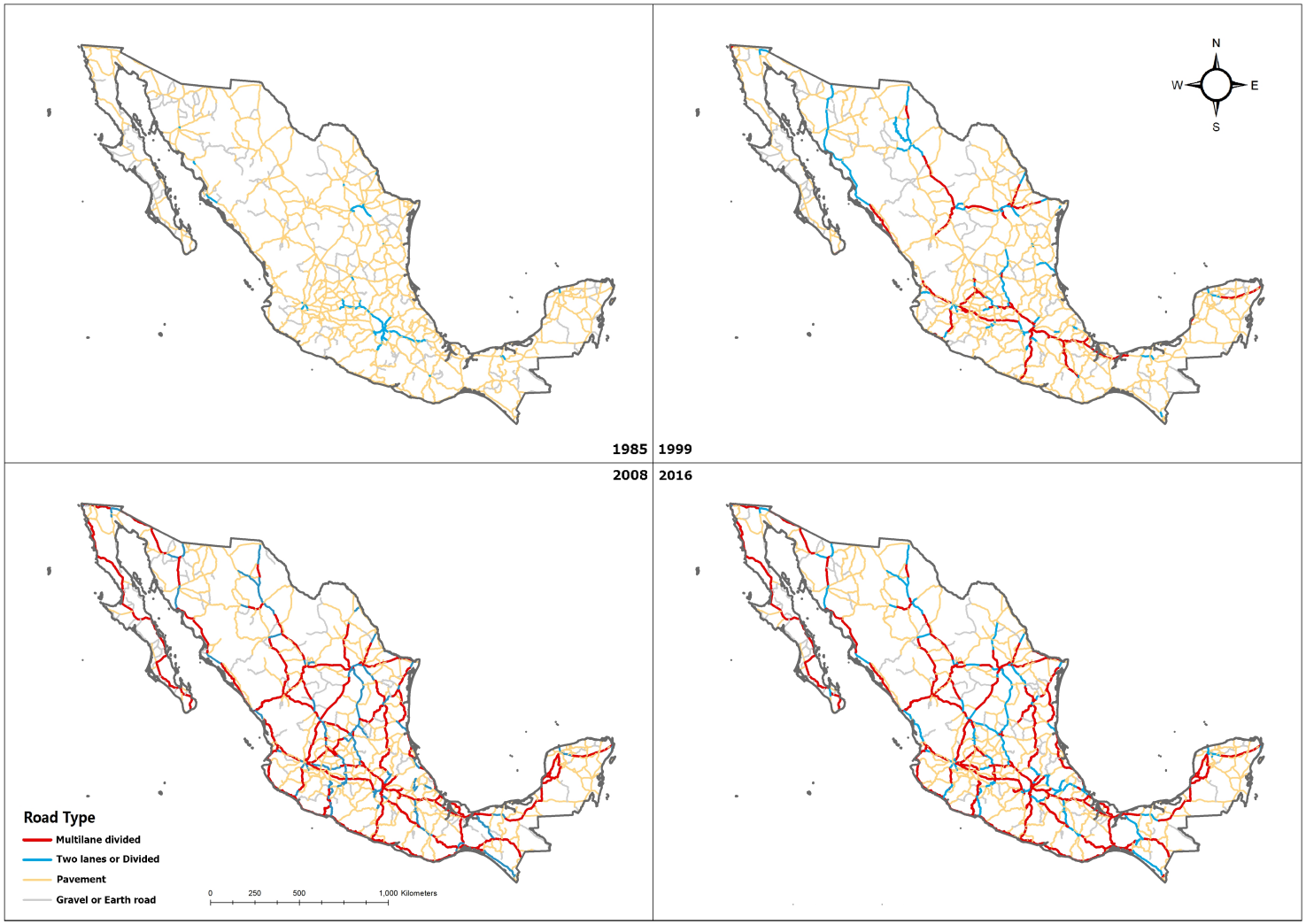
- Economic Censuses (locality): 1986 - 2014, with 5 year intervals
- Directory of Economic Units (firms): 2004 - 2014, with 5 year intervals

[2] Roads data

- Road types (American Automobile Ass'n., major roads only): 1985-2016
- Cross-sectional road geometry (DeLorme 2014)

We calculate road length by road type, travel times between localities, and local indicators of accessibility (for each year).

Road improvements (Mexico, 1985-2016)



Source: DeLorme (2014) and AAA (1985-2016).

Measuring specialization: the Krugman index

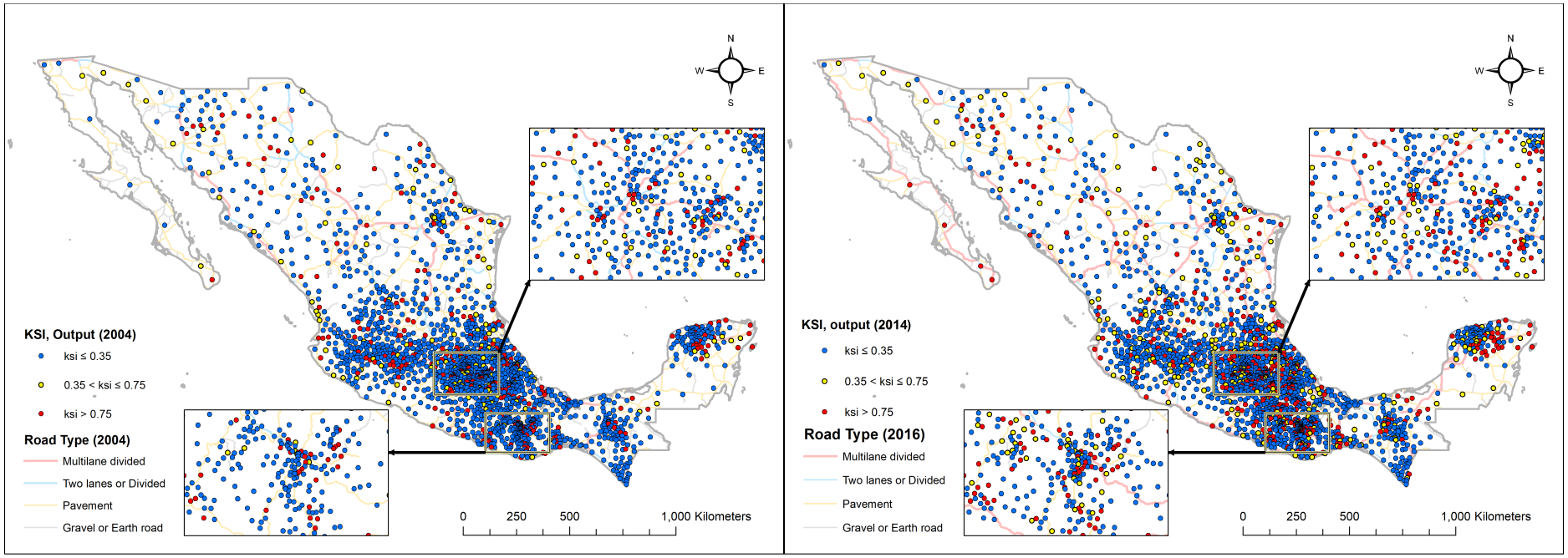
$$KSI_m = \sum_{i=1}^{I} |S_{m,i} - \overline{S}_i| \tag{1}$$

where $S_{m,i}$ is the output or employment share of industry i in locality m, $\overline{S}_i$ is the average share of industry i in the total output or employment across all localities in Mexico, and I is the number of industries.

Interpretation:

- KSI $>$ 0.75 —> highly specialized localities; KSI $\in (0.35, 0.75]$ weakly specialized localities; and KSI < 0.35 Not specialized localities

Output specialization (Mexico, 2004 and 2014)



Source: INEGI (2004, 2014), DeLorme (2014) and AAA (2004, 2016).

Increasing specialization: the share of highly specialized localities (KSI>0.75) rose from 6 to 10% between 2004 and 2014.

Measuring accessibility: market access & market potential

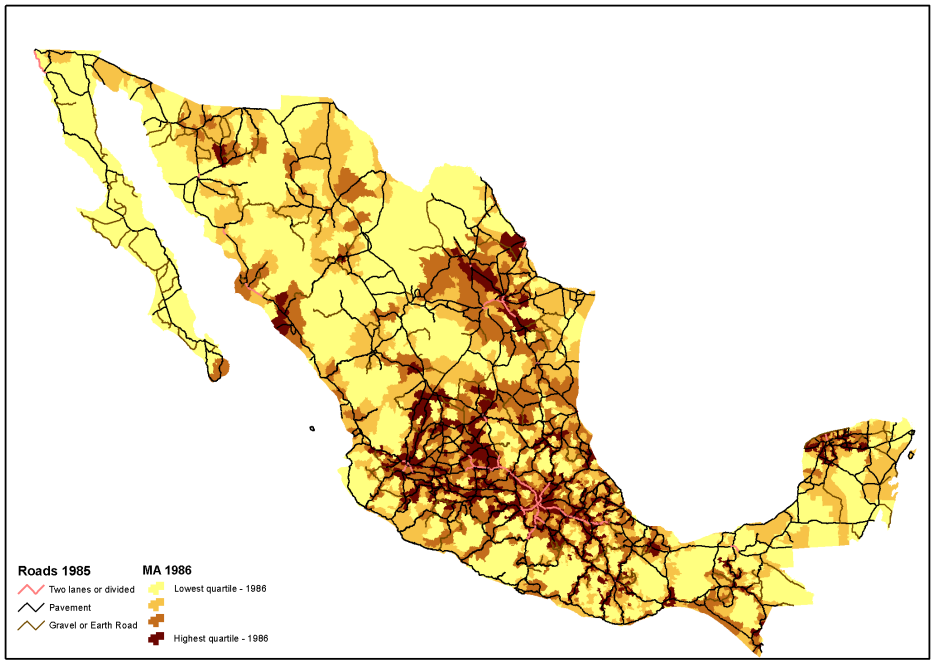
$$MA_{i,t} = \sum_{j \neq i} P_{j,t} \tau_{ij,t}^{-\theta} \tag{2}$$

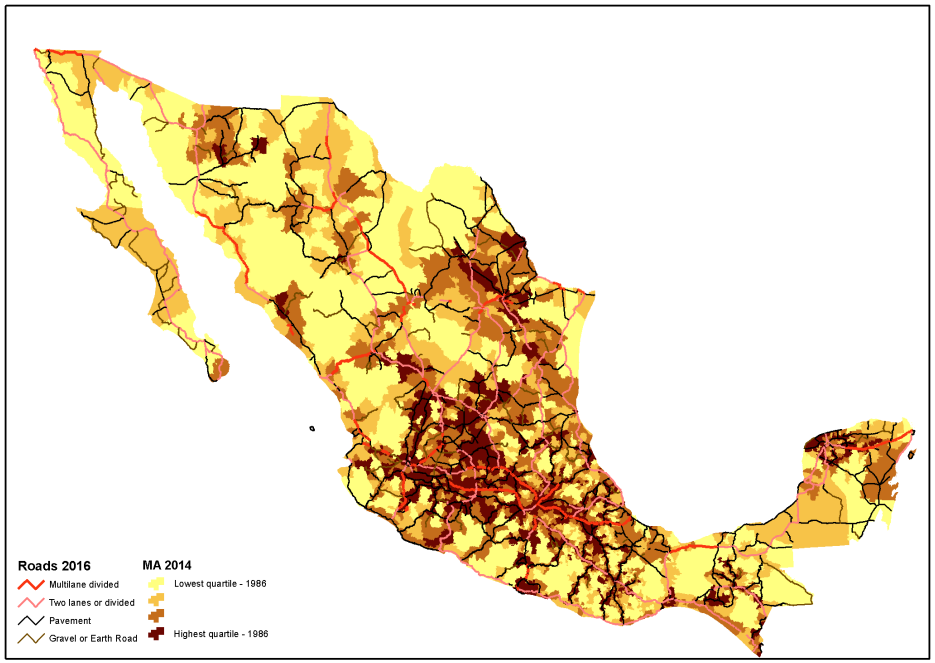
where $P_{j,t}$ is the population of locality j at time t, $\tau_{ij,t}$ is the time required to travel between locality i and j given the state of the road network at time t, and θ is a measure of trade elasticity (Donaldson 2016).

$$MP_{i,t} = \sum_{j \neq i} \frac{Y_{j,t}}{TC_{ij,t}^{\sigma-1}} \tag{3}$$

where $Y_{j,t}$ is locality j's total income (in real terms) at time t, $TC_{ij,t}$ is a transport cost (iceberg) function between localities i and j, and σ is an elasticity term (Pérez and Sandoval, 2015).

Market access (Mexico, 1986 and 2014)





Source: INEGI (1986 and 2014), DeLorme (2014) and AAA (1985, 2016).

Methodology

Empirical model

We work at the locality-year level and take advantage of the panel nature of our data to estimate the following model:

$$Y_{m,t} = \beta_M M_{m,t} + \beta_M^{int} M_{m,t} I_{m,t} + \beta_C C_{m,t} + \alpha_t + \mu_m + \epsilon_{m,t} \tag{4}$$

- Ym,t is the dependent variable (employment, specialization index)
- $M_{m,t}$ is the market access or market potential of the same locality
- $C_{m,t}$ is a vector of time-varying locality characteristics
- $I_{m,t}$ is an interaction term, α_t is a time dummy, μ_m is the location fixed effect, and $\epsilon_{m,t}$ is the error term

Identification issues

[1] Non-random road placement

- Road construction occurs in localities that would otherwise have experienced relative increases or decreases in employment or specialization.

- We instrument with 'doughnuts': excluding all localities j located within a 25, 50, or 75 km radius of locality i (see Jedwab and Storeygard, 2016).

[2] Recursion: structural endogeneity of MA/MP indicators

- MA_i = $f(P_j)$ –> corr. with $Empl_j$ = $f(MA_j)$ —> $f(P_i)$, therefore $Empl_i$ corr. MA_i

- We instrument with (i) counts of road intersections or (ii) a 'doughnut' of efficient road lengths in a given radius or directly regress on 'infrastructure only' variables (see Baum-Snow et al. 2017).

Results

Effects of market access on employment

Variables	Total employment			
	MA only	OLS	IV (Doughnut)	IV (Road count)
Market Access (MA)	0.176***	0.149***	0.208***	0.163***
	(0.015)	(0.011)	(0.014)	(0.020)
MA x Population dummy		0.072***	0.053***	0.063***
		(0.012)	(0.015)	(0.015)
MA x Education dummy		-0.047***	-0.049***	-0.047***
		(0.003)	(0.004)	(0.003)
MA x NAFTA dummy		-0.114***	-0.119***	-0.115***
		(0.002)	(0.003)	(0.002)
MA x Capital city		-0.023	-0.029	-0.023
		(0.023)	(0.039)	(0.025)
MA x Oil dummy		0.839**	0.756*	0.832**
		(0.385)	(0.403)	(0.400)
Education dummy		0.155***	0.124**	0.155***
		(0.058)	(0.055)	(0.052)
Population dummy		0.851***	0.736***	0.805***
		(0.080)	(0.082)	(0.092)
Constant	6.836***	5.790***		
	(0.084)	(0.076)		
Observations	11379	11379	9778	11251
Adj. R-squared	0.052	0.423	0.398	0.424

Note: * denotes significance at the 10% level, ** denotes significance at the 5% level, and *** denotes significance at the 1% level. The doughnut IV is calculated by excluding all localities within a 25km circle. The road count IV is the number of roads intersecting a circle of 10km radius.

Effects of accessibility on output specialization

	Krugman Specialization index: Output			
	Market Potential		Market Access	
	OLS	IV (Doghnuts)	OLS	IV (Doghnuts)
Market Potential or Market Access	2.913***	0.154	0.455***	0.704***
	(0.494)	(1.863)	(0.176)	(0.231)
MP or MA x Metropolitan dummy	-2.245***	0.464	-0.127	-0.286
	(0.507)	(1.772)	(0.146)	(0.187)
MP or MA x Education dummy	0.0694	0.172**	-0.259***	-0.291***
	(0.0448)	(0.0774)	(0.0768)	(0.0919)
MP or MA x Capital city	0.00864	0.00877	0.0458*	0.0837***
	(0.00871)	(0.00988)	(0.0239)	(0.0304)
MP or MA x Oil dummy	-0.423	-0.577	1.009	0.950
	(0.494)	(0.470)	(2.109)	(1.945)
Above median education	1.313***	1.264***	1.214***	1.286***
	(0.353)	(0.431)	(0.390)	(0.418)
Above median population	29.22***	-4.382	1.503	0.994
	(6.422)	(22.33)	(1.017)	(0.966)
Constant	-42.77***		-4.412***	
	(6.165)		(0.985)	
Observations	4599	3628	4303	3628
Adj. R-squared	0.0649	0.0498	0.0234	0.0233

Notes: * denotes significance at the 10% level, ** denotes significant at the 5% level, and *** denotes significance at the 1% level. The estimates are from the instrumented regression with the doughnut IV calculated by excluding all localities within a 25km circle. Results are robust to other IV strategies. Heteroskedasticity robust standard errors are given in parentheses.

Effects of infrastructure and access to external markets on employment

	Total employment		Manufacturing		Services		Commerce	
Variables	OLS	IV	OLS	IV	OLS	IV	OLS	IV
Road Efficiency	5.501***	6.633***	3.570***	4.301***	5.007***	6.044***	5.833***	**7.061*****
	(0.0941)	(0.0911)	(0.144)	(0.141)	(0.0793)	(0.0719)	(0.110)	(0.104)
Min travel cost to U.S. border	-3.271***	-0.404	-3.808***	-1.887***	-3.354***	-0.730**	-4.242***	**-1.222*****
	(0.431)	(0.404)	(0.669)	(0.634)	(0.363)	(0.318)	(0.470)	(0.437)
Min travel cost to port	1.522***	0.493	2.242***	1.509**	1.683***	0.743**	1.567***	0.573
	(0.467)	(0.406)	(0.737)	(0.660)	(0.383)	(0.333)	(0.527)	(0.468)
Above median education	0.224***	0.238***	0.339***	0.348***	0.159***	0.171***	0.130***	0.145***
	(0.0460)	(0.0416)	(0.0681)	(0.0630)	(0.0363)	(0.0325)	(0.0475)	(0.0438)
Above median population	0.427***	0.404***	0.314***	0.304***	0.415***	0.394***	0.420***	0.396***
	(0.0448)	(0.0405)	(0.0782)	(0.0666)	(0.0419)	(0.0363)	(0.0575)	(0.0510)
Constant	-61.14***		-38.67***		-55.82***		-65.98***	
	(1.341)		(1.978)		(1.139)		(1.609)	
Observations	11200	11200	10619	10614	11184	11184	10583	10575
Adj. R-squared	0.549	0.537	0.210	0.206	0.607	0.594	0.497	0.486

Note: * denotes significance at the 10% level, ** denotes significant at the 5% level, and *** denotes significance at the 1% level. The efficient roads doughnut IV is obtained by calculating the road efficiency units in a doughnut within two circles of 150 and 300 km radii.

Other findings

- Roughly similar results for market potential (except for specialization)

Robustness checks

- Use of another trade elasticity parameter (8.2 instead of 3.8)

- Use of different radii when excluding surrounding localities (25, 50, 75, 100, 200km)

Conclusion and Policy Relevance

Findings

Road improvements increased access to infrastructure and access to markets in Mexico.

These changes matter for explaining changes in the geography of economic activities and specialization

These effects are heterogeneous across sectors and economic regions.

Cheaper/quicker travel to the US border stimulates employment but cheaper/quicker travel to ports depresses employment. This could reflect trade openness and competition effects.

Next steps: explore the potential mechanisms at play.

Policy Relevance

Regional integration and infrastructure investment are policy directions to pursue

- Regional integration combines with investment in roads to stimulate growth through employment and specialization
- The process is dynamic and can benefit lagging areas
- Spatial effects are associated with openness to trade with the U.S. (NAFTA)