Paving the way to modern growth. Evidence from Bourbon roads in Spain

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This paper

- Analysis of the impact of the Spanish paved road network on local population growth before the railway era $\rightarrow$ Did the network generate a new population equilibrium?
- Two conflicting views in the historiography:
  - Spanish pre-railway inland transport as inefficient and costly, and one of the structural obstacles preventing market integration and economic development (Gómez Mendoza, 1989; Ringrose, 1970).
  - Increasing evidence on Spain's domestic market integration in the decades before 1860 (Barquín, 1997; Martinez Vara, 1999; Reher, 2001; Llopis and Sotoca, 2005; Grafe, 2012; Nogués-Marco et al., 2019).
- We approach this debate by analyzing the effects on local population growth of increasing accessibility through the road network.
- We also investigate potential mechanisms explaining the population effects of road accessibility.

Preview of results

- Using both binary and market access indicators, our analysis provides clear evidence of a positive effect of road accessibility on local growth→

→ Measuring accessibility by means of a binary indicator, we find a 47.2% additional higher growth between 1787 and 1857 for the municipalities crossed by a new road.

- This effect coincides with a negative impact of roads on municipalities around those with road access →

→ We interpret this as an indication of a relocation process of population.

- The impact was much larger on smaller municipalities, which would be consistent with a dynamics of rural-to-rural migration.
- These findings are consistent with the most positive hypotheses on the efficiency of the Spanish transport sector before the railways.

Novelties and contributions of the paper

- One of the first papers employing this approach to measure the impact of a pre-railway infrastructure.
- Municipal level of analysis for the late 18th-early 19th century.
- Precise geo-coded digitalization of the historical road network.

Outline

1. Related literature
2. Historical background
3. Data
4. Empirical framework
5. Results
6. Potential mechanisms
7. Conclusions

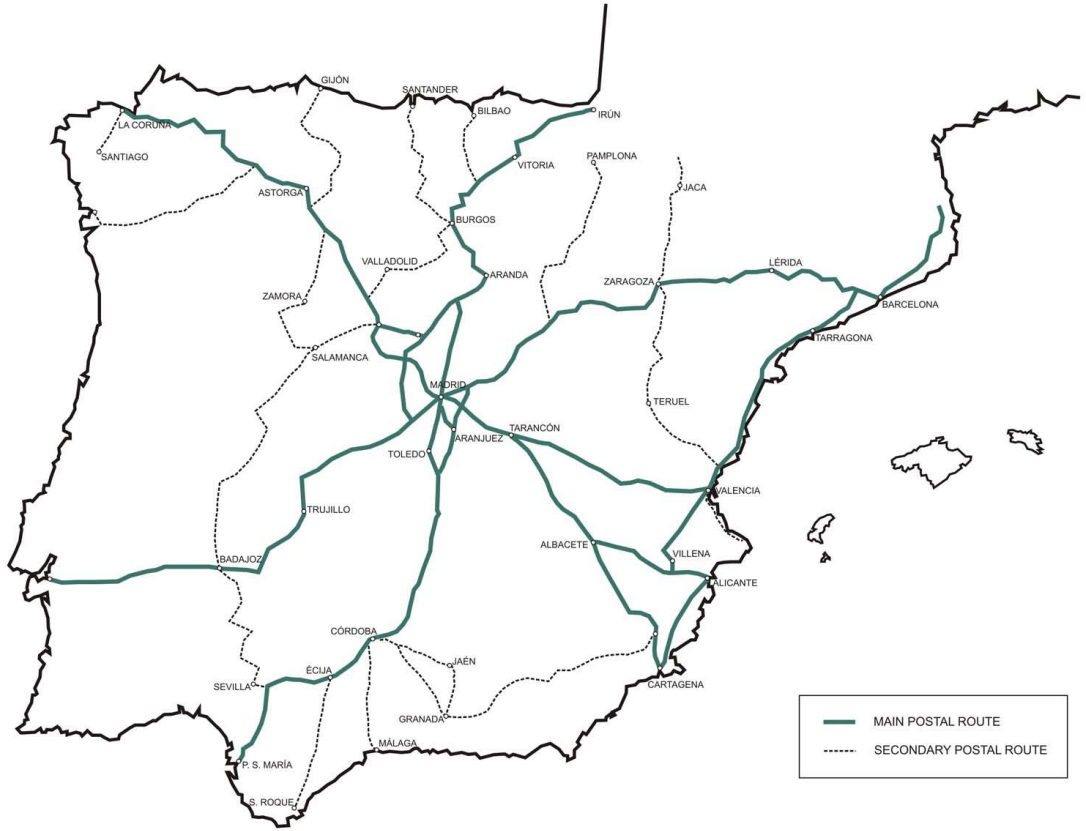
Related literature

- Research on the local economic impact of increasing accessibility through transport networks.
  - Railways: Atack et al. (2010); Banerjee et al. (2020); Berger and Enflo (2017); Berger (2019); Bogart et al. (2018); Buchel and Kyburz (2020); Donaldson (2018); Donaldson and Hornbeck (2016); Hornung (2015); Jedwab et al. (2015).
  - Motorways: Michaels (2008); Gibbons et al. (2019); Baum-Snow (2007); Duranton and Turner (2012); Garcia-López et al. (2015); Baum-Snow et al. (2017); Bird and Straub (2020); Chandra and Thompson (2000).
- Literature on increasing market integration in the European/Spanish economies in the early 19th century: Barquín (1997); Martinez Vara (1999); Reher (2001); Llopis and Sotoca (2005); Grafe (2012); Nogués-Marco et al. (2019); Federico and Persson (2010); Chilosi et al. (2013); Uebele (2012).

Historical background (I)

- The consolidation of the Bourbon dynasty after the War of Succession (1701-1713) started a project of administrative modernisation of the country. →

→ The government nationalized and centralized the postal service in 1716 and completely reorganized it with a predominantly radial character, although without significant infrastructure investment (post roads remained largely unpaved and of low standards).



Historical background (II)

- In 1747 the government established a regular funding by the Royal Treasury for the development and conservation of the main road network.
- A systematic construction policy was adopted in 1761, when a royal decree approved the construction of a new road network →

→ This construction plan should start with the roads that connected the Court with the provinces →

→ The plan was clearly aimed at a better communication between Madrid and the rest of the territory, in order to ease the administration and control of the country.

- The network length reached 8,324 km in 1855, and by that year Madrid was already connected with the main cities of the country with high quality paved roads.
- Dramatic reduction in travel times: from around 13 to 3-4 days between Madrid and Barcelona, for instance

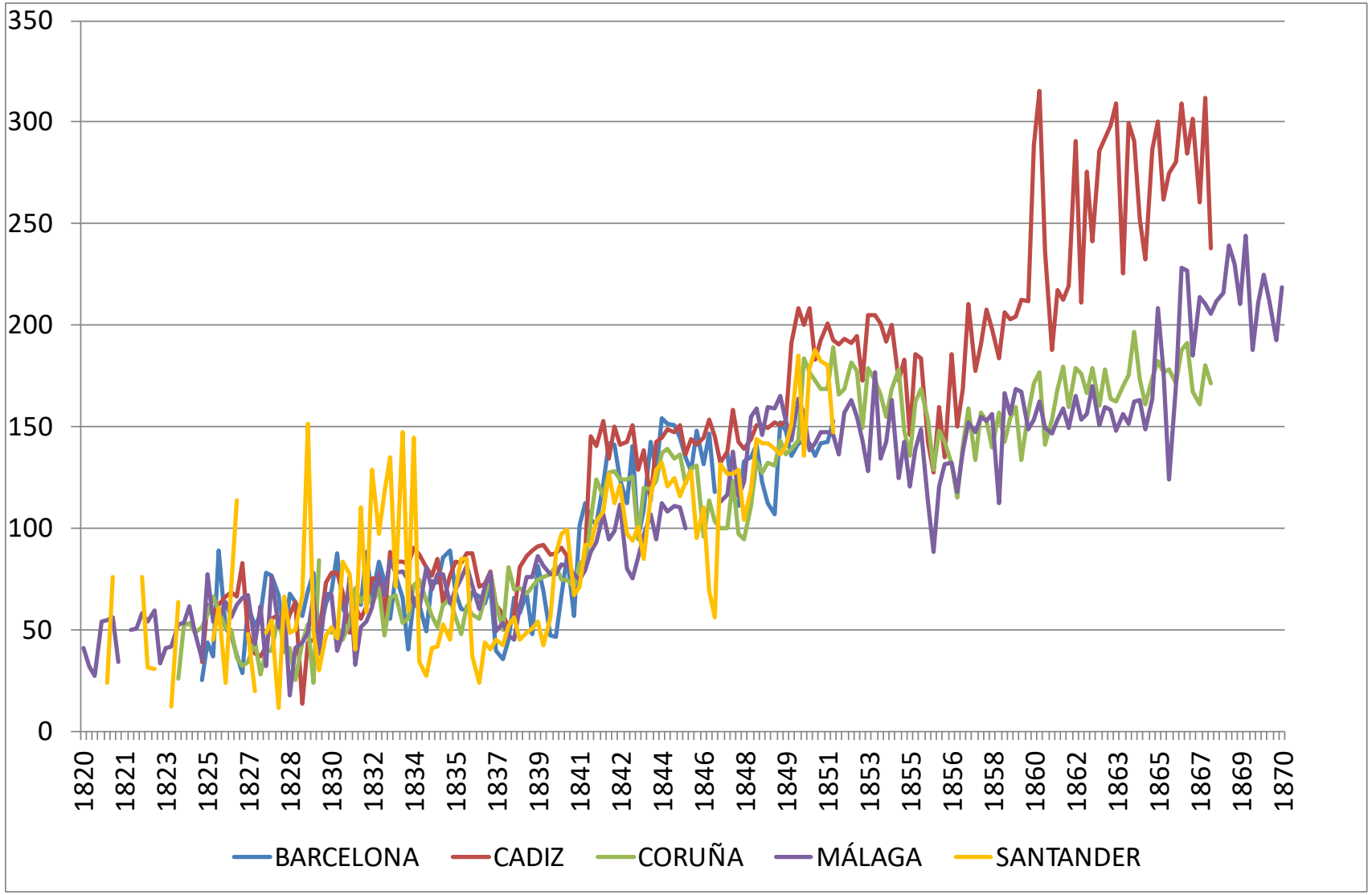
(a) 1778

(b) 1808

(c) 1840

(d) 1855

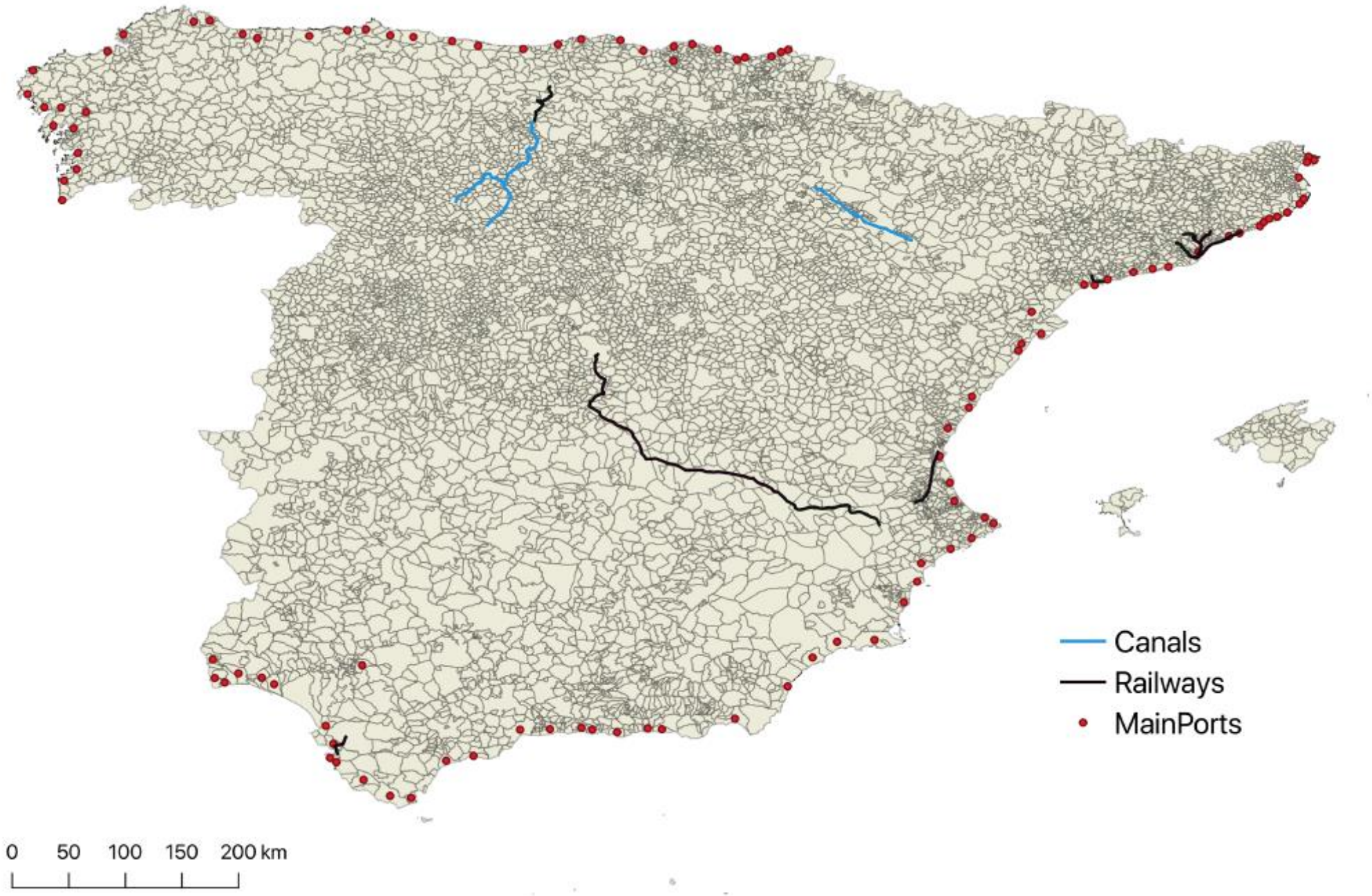
Daily speed of postal services (Bank of Spain correspondence, kms. per day)



Data

- Population:
  - *Censo de Floridablanca*, 1787.
  - 1857 population census (INE).
- Roads:
  - *Memoria sobre el estado de las Obras Públicas en España en 1856*.
  - Madrazo (1984): network status in 1752, 1778, 1808, 1840 and 1855.
  - Madrazo (1984); Grafe (2012); Nogues-Marco, Herranz-Loncan and Aslanidis (2019): travel speeds and costs.
- Control variables:
  - Railroads: García Raya (2006).
  - Navigable canals: Google Maps.
  - Ports: Dirección General de Aduanas (1857).
  - Coastline and rivers: Instituto Geografico Nacional (IGN).
  - Main post stops: Ita(1789).

Source: *Memoria sobre el estado de las Obras Públicas en España en 1856*


Canals
Railways
MainPorts
0 50 100 150 200 km

Empirical framework (I)

- Transport infrastructure is not randomly allocated across space→

→We apply several strategies to deal with potential endogeneity problems:

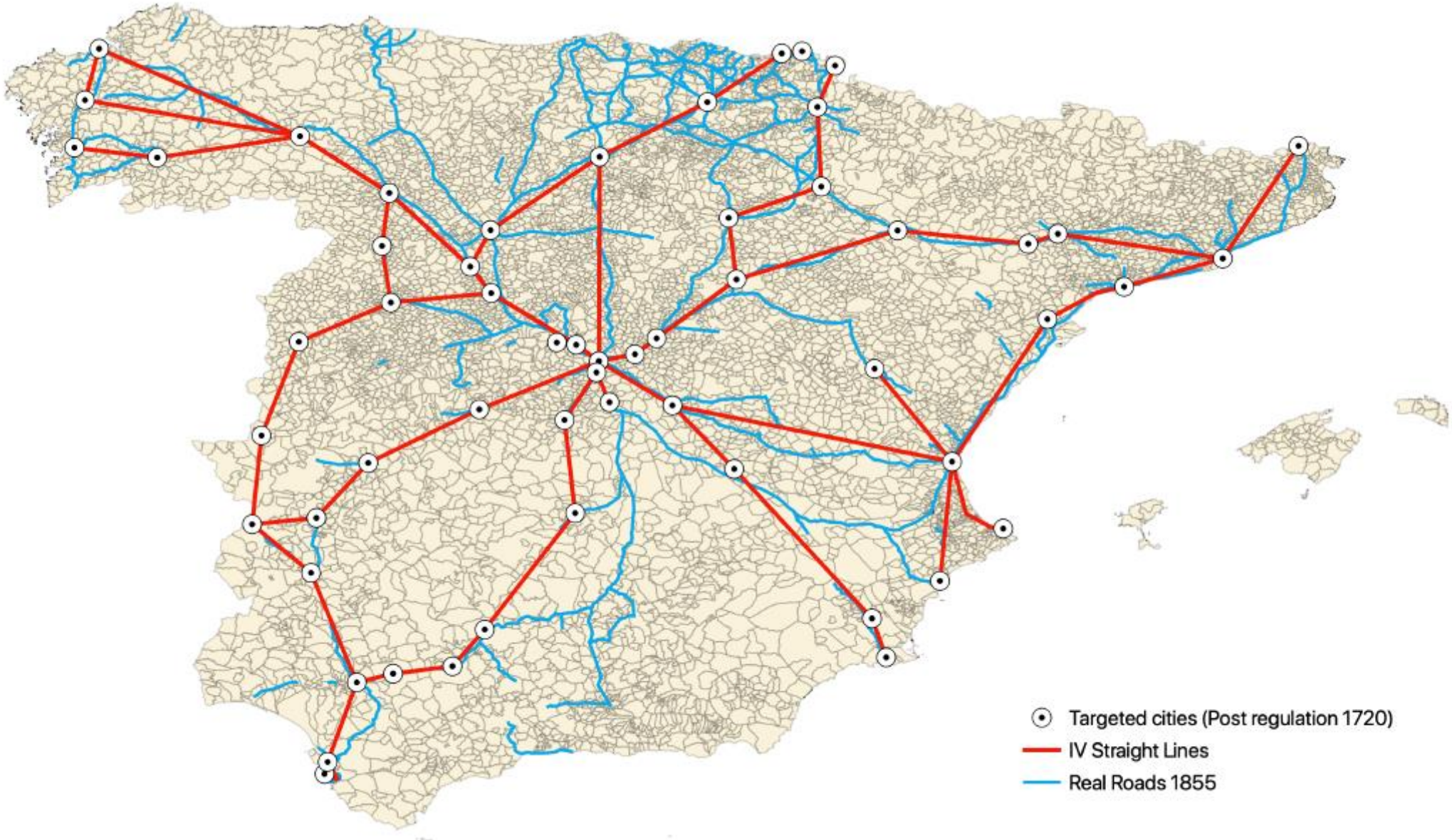
  - Quasi-natural experiment: non economic reasons for route selection.
  - Inconsequential unit approach: we remove 57 targeted cities, based on the 1720 regulation of postal services, and consider those in the middle as randomly selected.
  - Instrumental variable approach → use of straight lines connecting the targeted nodes as instruments.

y Leguas que ay de diſtancia de vnos à otros Lugares, y han de ſatisfacer à los que hizieren viages, y cobrar los Maeſtros de Poſtas.

Carrera deſde Madrid à Bayona de Francia, y paſſa por Burgos, Vitoria, y San Sebaſtian.

	Leguas.
De Madrid à Alcobendas.	3.
A San Aguſtin.	3.
Cavanillas.	3.
Uilla de Buytrago.	4.
Somoſierra.	3.
Caſtrillejo.	3.
Freſnillo de la Fuente.	2½.
La Onrubia.	3.
Atanda de Duero.	3.
Bahabon.	4.
Ciudad de Lerma.	3.
Madrigalejo.	2½.
Sarracin.	3.
Ciudad de Burgos.	2.
De Madrid à Burgos ay 42. leguas, y 14. Poſtas, y proſigue la carrera haſta Vitoria.	42.
De Burgos à Quintanapalla.	3.
A Caſtil de Peones.	3.
Bribieſca.	2.
Zuñeda.	3.
Ameyugo.	3.
Miranda Ebro.	2½.
La Puebla.	2½.
Ciudad de Vitoria.	3.
De Burgos a Vitoria ay leguas 21. y 8. Poſtas, y proſigue la carrera à San Sebaſtian.	21.
De Vitoria à Vdicana.	3.
Galarreta.	3½.
Zegama.	3.
Toloſa.	3.
Vrnieta.	3.
Ciudad de San Sebaſtian.	2.
De Vitoria à San Sebaſtian ay 19. leguas y media, y en ellas ſiete Poſtas, y proſigue la carrera haſta Bayona de Francia.	19½.

De


Targeted cities (Post regulation 1720)
IV Straight Lines
Real Roads 1855

Empirical framework (II)

Long-run (1857-1787) population growth model (IV approach) $\rightarrow$

$\rightarrow$ Binary (1/0) and Market access indicators of accessibility.

$$Accessibility_m = \alpha_0 + \beta_1 StraightLines_m + \beta_2 ln(pop_{m,1787}) + \beta_3 X_m + \theta_p + \epsilon_m \quad \text{(First Stage)}$$

$$ln(pop_{m,1857}) - ln(pop_{m,1787}) = \alpha_0 + \beta_4 \widehat{Accessibility}_m + \beta_5 ln(pop_{m,1787}) + \beta_6 X_m + \theta_p + \epsilon_m \quad \text{(Second Stage)}$$

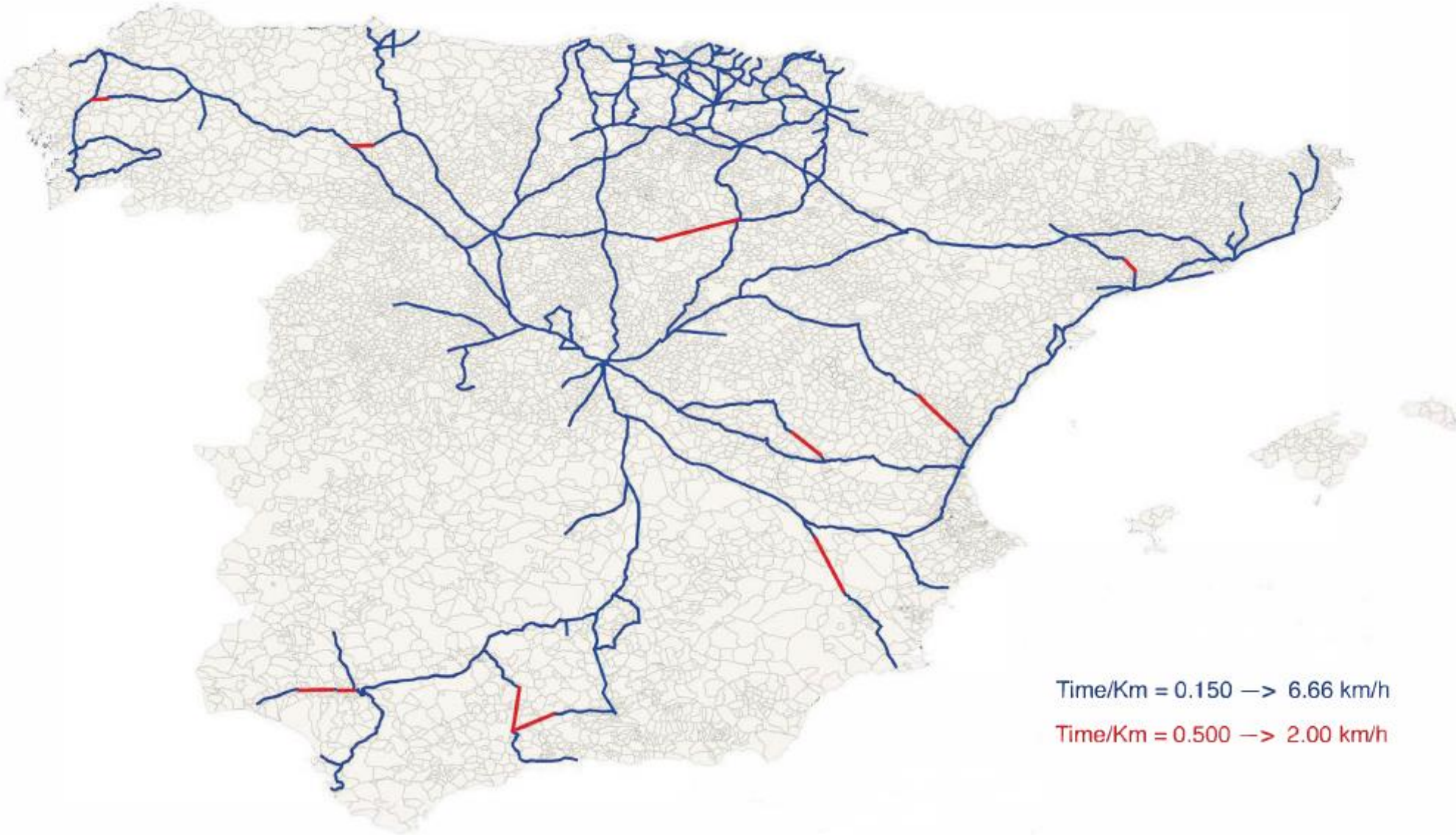
$\rightarrow$ We use historical (1860) judicial districts fixed effects and cluster standard errors at the level of those districts.

Empirical framework (III)

- Market access $\rightarrow$ Weighted sum of inverted travel times to all other municipalities through the road network, using as weights the initial population at destination.
- Travel times are computed with a least cost path algorithm

$$M_{o,t} = \sum_{d} (t_{o,d})^{-\theta} * W_d$$

$$\text{We set } \theta = 1 \text{ and } W_d = pop_{j,1787}\text{: } A_m = \sum_{j=1}^{M-1} \frac{pop_{j,1787}}{t_{m,j}}$$


Time/Km = 0.150 —> 6.66 km/h
Time/Km = 0.500 —> 2.00 km/h

Results (I): binary accessibility indicator

	(1)	(2)	(3)	(4)	(5)	(6)
Road accessibility (0/1)	0.051***	0.107***	0.087***	0.284***	0.449***	0.472***
	(0.020)	(0.015)	(0.015)	(0.101)	(0.123)	(0.141)
Log_population 1787	-0.130***	-0.232***	-0.248***	-0.144***	-0.255***	-0.269***
	(0.010)	(0.010)	(0.011)	(0.012)	(0.012)	(0.012)
Model	OLS	OLS	OLS	IV	IV	IV
Obs.	7216	7216	7216	7216	7216	7216
R2	0.095	0.455	0.466	0.052	0.387	0.384
First-Stage F-Statistic				59.65	29.36	27.02
Geographical controls			✓			✓
Accessibility controls			✓			✓
Other controls			✓			✓
Fixed effects		✓	✓		✓	✓

Results (II): Market access

	(1)	(2)	(3)	(4)	(5)	(6)
Log Market Access	0.004**	0.009***	0.007***	0.026***	0.042***	0.045***
	(0.002)	(0.001)	(0.001)	(0.009)	(0.012)	(0.014)
Log_population 1787	-0.131***	-0.232***	-0.248***	-0.144***	-0.255***	-0.268***
	(0.010)	(0.010)	(0.011)	(0.011)	(0.012)	(0.012)
Model	OLS	OLS	OLS	IV	IV	IV
Obs.	7216	7216	7216	7216	7216	7216
R2	0.096	0.455	0.466	0.051	0.383	0.377
First-Stage F-Statistic				56.81	28.21	25.57
Geographical controls			✓			✓
Accessibility controls			✓			✓
Other controls			✓			✓
Fixed effects		✓	✓		✓	✓

Potential mechanisms (I)

- We suggest that the population impact that we detect was the outcome of labour relocation (migration), given the absence of significant changes in the Spanish demographic regime (fertility/mortality) at the time $\rightarrow$

$\rightarrow$This would be consistent with recent evidence on the intensification of Spanish domestic migration in the central decades of the 19th century (Santiago-Caballero, 2020).

$\rightarrow$ It would also be consistent with the increasing demand of services along the routes, associated to traffic growth (e.g. yearly passenger transport increased from 2,000 in 1818 to 825,000 in 1850).

Table 4 Stock of migrants per 100 inhabitants, 1841–1930

	Men	Women	Total		Men	Women	Total
1841	6.5	3.9	5.4	1887	8.8	7.3	8.0
1850	6.8	4.4	5.6	1900	9.6	8.5	9.0
1860	8.1	5.3	6.7	1910	9.7	8.8	9.2
1870	8.6	6.1	7.4	1920	10.3	9.5	9.9
1877	8.6	6.8	7.7	1930	12.4	12.5	12.4

"(…) together with the staging post and the inn, resources at the service of traffic include the helper, ready to cover the hoofs of the horses, the blacksmith and wagoner to mend the cart axles, rods and wheels; the leather craftsman that sells or fixes harnesses, whips, collars and other tack (...)"

(Madrazo, 1984, p. 563).

Potential mechanisms (II)

- We test for short-distance relocation effects by comparing the impact of road accessibility on the municipalities with access and on those around them.
- We analyse the type of labour movement by testing if the impact of accessibility was higher in large or small municipalities.

Potential mechanisms (III)

	OLS		
	(1)	(2)	(3)
Municipality to new road: 0-2km	0.069***		
	(0.017)		
Municipality to new road: 2-4km	-0.024		
	(0.021)		
Municipality to new road: 4-6km	-0.034*		
	(0.019)		
Municipality to new road: 0-3km		0.058***	
		(0.018)	
Municipality to new road: 3-6km		-0.036**	
		(0.017)	
Municipality to new road: 6-9km		-0.014	
		(0.016)	
Municipality to new road: 0-4km			0.041**
			(0.019)
Municipality to new road: 4-8km			-0.029
			(0.018)
Municipality to new road: 4-12km			-0.018
			(0.017)
ln(Population 1787)	-0.248***	-0.247***	-0.246***
	(0.011)	(0.011)	(0.011)
Controls	✓	✓	✓
Fixed effects	✓	✓	✓
R2	0.465	0.465	0.464
Obs.	7216	7216	7216

$\Rightarrow$ Evidence of short-distance relocation effect.

Potential mechanisms (IV)

	OLS				IV			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Road accessibility (0/1)	0.051***	0.164***	0.070***	0.271***	0.472***	0.618***	0.235*	0.830***
	(0.020)	(0.025)	(0.021)	(0.040)	(0.141)	(0.183)	(0.122)	(0.237)
Accessibility × Dimension		-0.259***	-0.170***	-0.324***		-0.734***	-0.476***	-0.879***
		(0.027)	(0.028)	(0.039)		(0.126)	(0.096)	(0.185)
ln(Population 1787)	-0.130***				-0.269***			
	(0.010)				(0.012)			
Controls	✓	✓	✓	✓	✓	✓	✓	✓
Fixed effects	✓	✓	✓	✓	✓	✓	✓	✓
First-Stage F-Statistic					27.02	13.21	15.07	15.81
R2	0.095	0.298	0.291	0.299	0.384	0.236	0.271	0.251
Obs.	7216	7216	7216	7216	7216	7216	7216	7216

$\Rightarrow$ Higher impact on smaller municipalities.

$\Rightarrow$ Evidence consistent with rural-to-rural migration.

Conclusions

- Using two different indicators of accessibility to the road network (binary/market access), we show that municipalities which had got access to the network by 1855 had a higher long-term population growth than the rest.
- We suggest that rural-to-rural migration was the main channel behind the population growth of the municipalities crossed by the new roads.
- Our results reinforce the idea that the Spanish transport sector was far of stagnant before the arrival of the railways, and that it contributed to the slow but gradual process of transformation of the Spanish economy that was taking place at the time.

Thanks!