The spatial effects of transport infrastructures on growth
Analysis of the regional convergence in Spain

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Outline of the presentation

- Introduction
- Literature review and institutional background
- Empirical strategy
  1. Data
  2. The econometric model
  3. Results
- Conclusions
- Discussion

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- Transport infrastructures are considered a necessary element for economic progress and development
- Infrastructure investment involves the allocation of huge amount of resources
- A particular attribute of the investment in transport infrastructure is to impact not only in the region where the investment was made, but in nearby areas
- Spillover effects are mainly expected in the transport modes with network characteristics, typically railways and roads

- To analyze if there has been a process of economic convergence among Spanish provinces
- To assess whether transport infrastructures are significant for explaining economic growth and regional convergence
- To study the contribution of public transport capital investment to the gross regional product

- Few studies on the impact of transport infrastructures on regional convergence
- Include the direct, indirect and total impacts of network infrastructures (roads and railways) and single infrastructures (airports and ports)

- The methodology is based on spatial econometric techniques, by applying a Spatial Durbin Model (SDM) which measures the effects on the region in which the investment is made and the spillover effects on neighboring regions

- Findings of great relevance due to the important amount of resources allocated towards regional convergence in this country

- Influential papers of Aschauer(1989,1990,1993)
- Empirical studies that followed Aschauer did not differ particularly in the theoretical aspects, but in applying econometric procedures
- In general, more consensus about a positive impact

- Particularly for Spain:

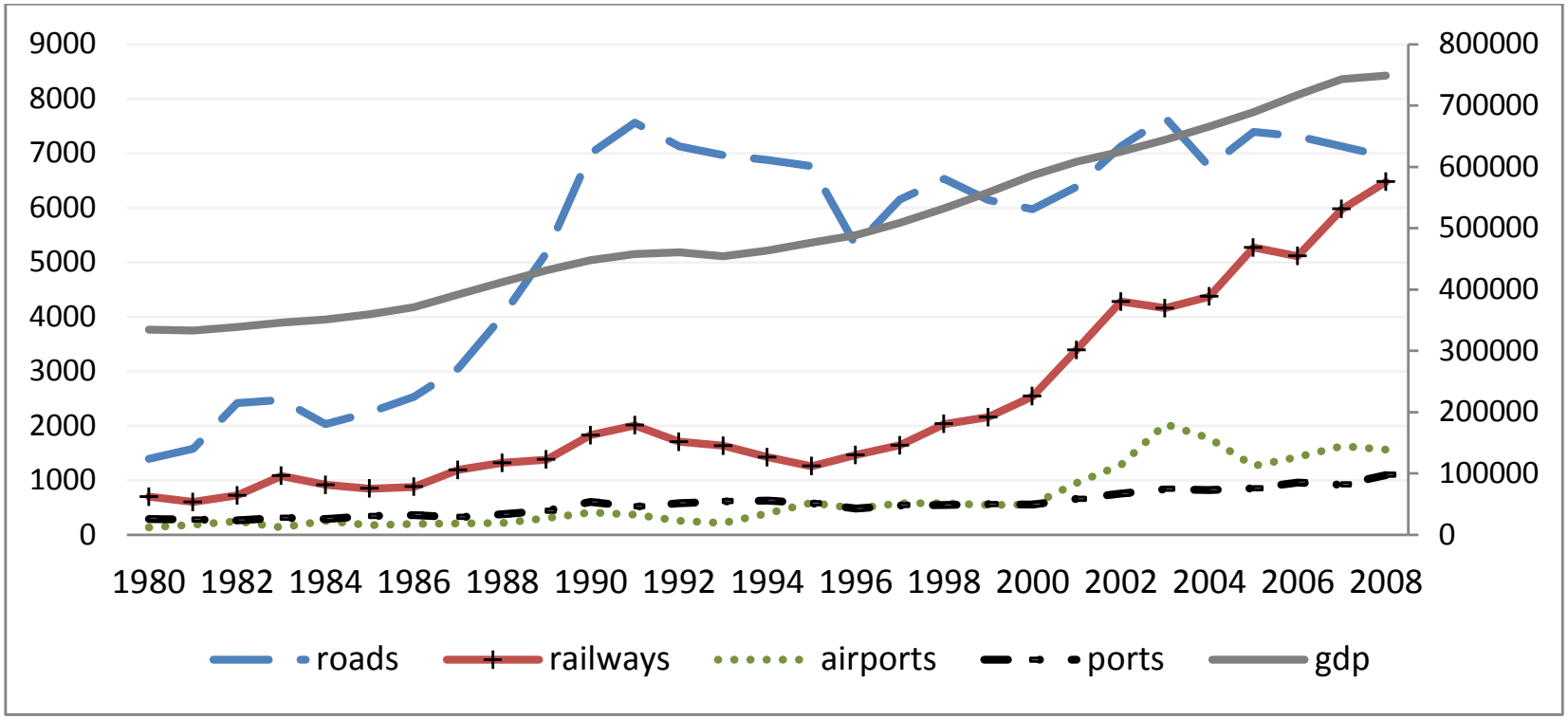
  1. Recent contributions employed different theoretical frameworks to capture the spatial externalities of transport infrastructure on the regional and sectoral growth

  2. Positive direct effects and inconclusive indirect effects

- Empirical literature provides divergent results:
  1. Cross-country analysis confirmed the existence of a convergence process with positive impact of infrastructures
  2. In country-specific articles the evidence is not that clear
- In particular:
  1. Studies of European regions found evidence of convergence process with positive and significant spatial spillovers (Florio, 2010; Del Bo et al., 2010)
  2. For Greek regions,Rodriguez-Pose et al.(2012) found positive impact of spatial spillovers on regional economic growth (particularly due to transport infrastructures), although no impact on reducing disparities.

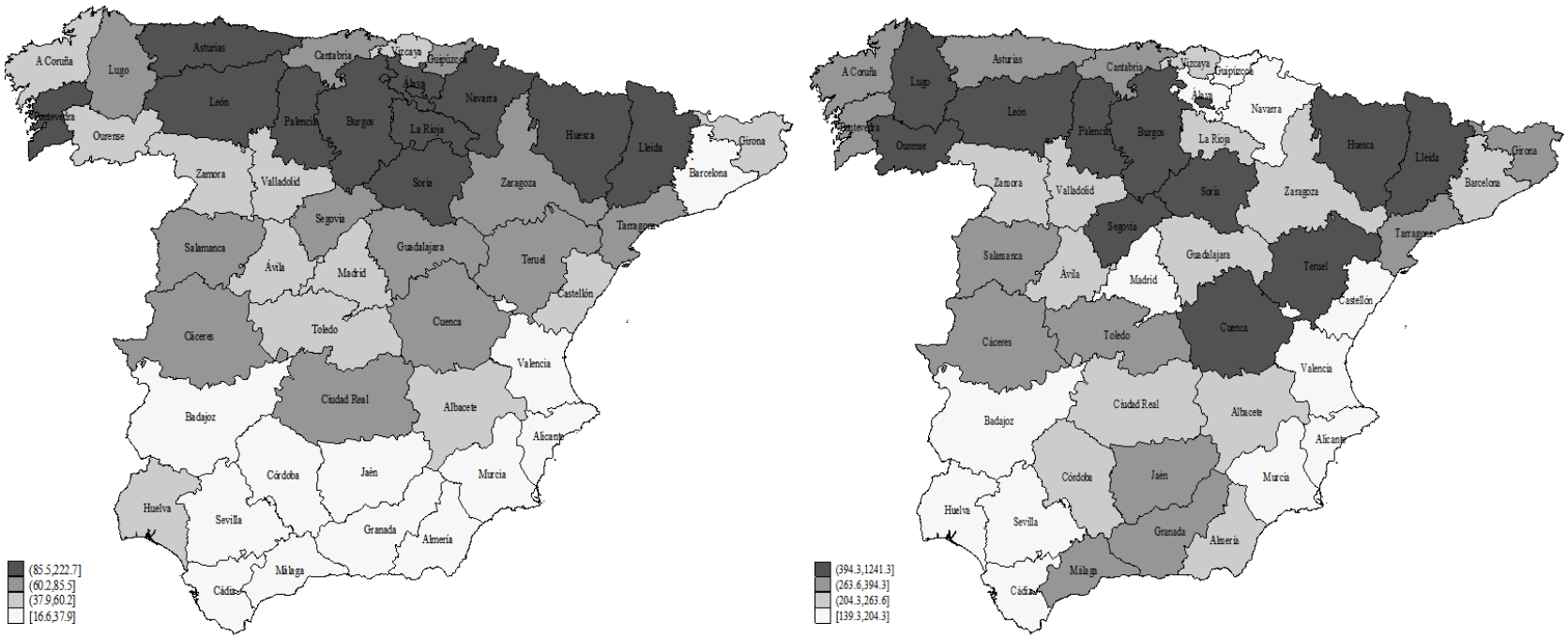
- In Spain, a great amount of resources have been devoted to expand its infrastructure capacity: the EU country with the most extensive motorway network and to develop the most extensive high-speed railway network in Europe
- Equity as an explicit objective of infrastructure investment in Spain

Evolution of transportation investment in Spain, 1980-2008

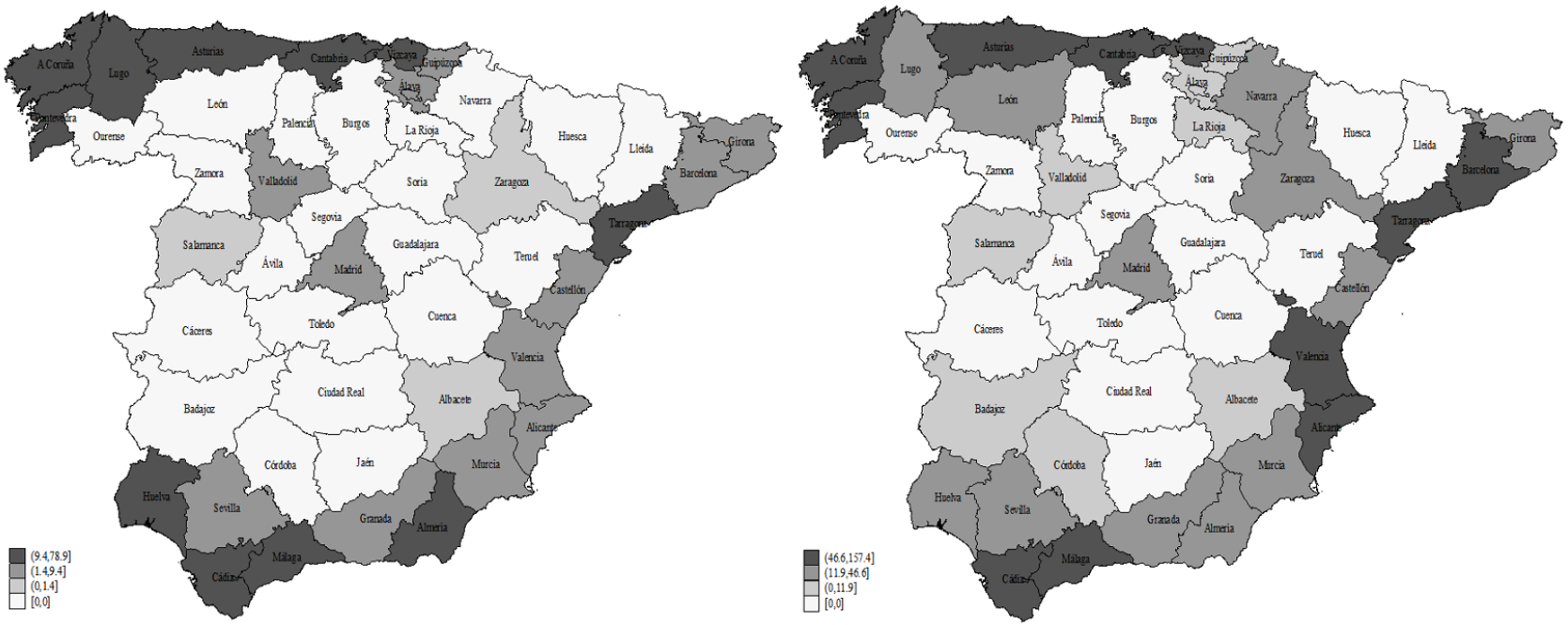


Thousands of constant euros, 2000

Distribution of network investment in 1980 (left) and 2008 (right) at NUTS-3



Distribution of single investment in 1980 (left) and 2008 (right) at NUTS-3



- Aim:
  1. To test economic convergence among Spanish provinces during 1980-2008
  2. To assess whether public investment in transport infrastructures are significant in explaining regional convergence as well as significant contributors to regional GDP

- The hypothesis of convergence (β-convergence model)
  1. Refers to an inversely relationship between the growth rate of per capita income and the starting level of per capita income
  2. In particular, it is a situation where the gap in per capita output among regions tends to decrease over time

- Absolute β-convergence

  Growth rate is explained only by the initial level of per capita income, which means the existence of unique long-run steady-state equilibrium

- Conditional β-convergence

  Specification includes some other variables in order to control for attributes that may produce different steady-state growth rates among regions

- Yearly data of 47 Spanish provinces with the exception of the islands and the autonomous cities of Ceuta and Melilla
- Sources of information:
  1. Instituto Valenciano de Investigaciones Economicas (IVIE)
  2. Instituto Nacional de Estadsticas (INE)
  3. Cambridge Econometrics European database

- Panel data analysis to consider both the cross-section and time series dimensions of the processes (FE estimator)
- Spatial panel data specification (Spatial Durbin Model (SDM)) to capture for potential externalities
- The implication to this study:
  1. The economic performance of a particular region depends, to some extent, of the value that the variable assumes in nearby areas, what justifies the inclusion of a spatially lagged dependent variable
  2. A change in an independent variable for a particular province potentially affects the economic activity in all other observations

Three specifications of the SDM model:

$$\Delta(Gdp_{it+1,t}) = \alpha + W\rho Gdp_{it+1,t} + \beta ln(Gdp_{it}) + W\gamma ln(Gdp_{it}) + \mu_i + \epsilon_{it} \quad (1)$$

$$\Delta(Gdp_{it+1,t}) = \alpha + W\rho Gdp_{it+1,t} + \beta_1 ln(Gdp_{it}) + \beta_2 ln(Network_{it}) + \beta_3 ln(Single_{it}) + W\gamma_1 ln(Gdp_{it}) + W\gamma_2 ln(Network_{it}) + W\gamma_3 ln(Single_{it}) + \mu_i + \epsilon_{it} \quad (2)$$

Specifications 1 and 2 are taking annual growth rates

$$
\begin{aligned}
Gdp_{it} = \alpha + W\rho Gdp_{it} + \beta_1 ln(Network_{it-1}) + \\
\beta_2 ln(Single_{it-1}) + \beta_3 PopDensity_{it}) + \\
\beta_4 LProductivity\_a_{it} + \beta_5 LProductivity\_i_{it} + \\
\beta_6 LProductivity\_s_{it} + \beta_7 Share\_a_{it} + \beta_8 Share\_i_{it} + \\
\beta_9 Valuehk_{it} + W\gamma_1 ln(Network_{it}) + W\gamma_2 ln(Single_{it}) + \\
\mu_i + \epsilon_{it}
\end{aligned}
\tag{3}
$$

In all cases SDM with three different specifications of the distance matrix: standardized contiguity, standardized inverse of the squared distance and the five nearer neighbors

Estimation results of Absolute Convergence (bias-corrected fixed effects)

VARIABLES	W_contiguity	W_distance	W_nearestn
Gdp	-8.339	-8.903	-8.778
	(1.286)***	(1.310)***	(1.271)***
W*Gdp	8.120	8.663	8.631
	(1.331)***	(1.355)***	(1.313)***
W*Y	0.411	0.450	0.596
	(0.030)***	(0.031)***	(0.030)***
sigma2_e	8.723	8.714	8.175
	(0.351)***	(0.350)***	(0.328)***
Spatial specific effects	YES	YES	YES
Observations	1,269	1,269	1,269
R-squared	0.016	0.017	0.018
Log-likelihood	-3,202.55	-3,198.97	-3,161.12

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Absolute Convergence, the direct and indirect effects of the explanatory variable

VARIABLES		W_contiguity	W_distance	W_nearestn
Gdp	Direct effect	-7.828	-8.459	-8.501
		(1.015)***	(1.048)***	(1.038)***
	Indirect effect	7.502	8.079	8.212
		(1.272)***	(1.329)***	(1.501)***
	Total effect	-0.326	-0.381	-0.288
		(0.740)	(0.781)	(1.039)

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Estimation results of Conditional Convergence
(bias-corrected fixed effects)

VARIABLES	W_contiguity	W_distance	W_nearestn
Gdp	-8.9450	-9.2353	-9.2955
	(1.305)***	(1.320)***	(1.285)***
Single	0.0104	0.0001	0.0068
	(0.037)	(0.037)	(0.036)
Network	0.3933	0.3597	0.3708
	(0.201)*	(0.201)*	(0.204)*
W*Gdp	8.2552	8.6313	9.2217
	(1.454)***	(1.483)***	(1.513)***
W*Single	-0.1489	-0.1323	-0.1897
	(0.076)*	(0.080)*	(0.098)*
W*Network	0.0343	0.0248	-0.1477
	(0.291)	(0.307)	(0.338)
W*Y	0.4161	0.4439	0.5927
	(0.030)***	(0.031)***	(0.033)***
sigma2_e	8.6641	8.6697	8.1246
	(0.349)***	(0.348)***	(0.326)***
Spatial specific effects	YES	YES	YES
Observations	1,269	1,269	1,269
R-squared	0.019	0.021	0.021
Log-likelihood	-3197.73	-3195.03	-3156.89

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Conditional Convergence, the direct and indirect effects
of the explanatory variables

VARIABLES		W_contiguity	W_distance	W_nearestn
Gdp	Direct effect	-8.4550	-8.8176	-8.9978
		(1.040)***	(1.065)***	(1.054)***
	Indirect effect	7.2543	7.7071	8.8101
		(1.473)***	(1.598)***	(2.110)***
	Total effect	-1.2007	-1.1105	-0.1877
		(1.180)	(1.341)	(1.902)
Single	Direct effect	-0.0013	-0.0083	-0.0048
		(0.044)	(0.044)	(0.043)
	Indirect effect	-0.2067	-0.1981	-0.3987
		(0.124)*	(0.141)	(0.242)*
	Total effect	-0.2080	-0.2064	-0.4036
		(0.150)	(0.167)	(0.266)
Network	Direct effect	0.4288	0.3906	0.3892
		(0.215)**	(0.216)*	(0.218)*
	Indirect effect	0.3468	0.3469	0.2050
		(0.410)	(0.461)	(0.673)
	Total effect	0.7756	0.7375	0.5942
		(0.473)	(0.524)	(0.720)

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Estimation results of the impacts on *per capita* GDP
(bias-corrected fixed effects)

VARIABLES	W_contiguity	W_distance	W_nearestn
Single(-1)	0.0032	0.0026	0.0028
	(0.001)***	(0.001)***	(0.001)***
Network(-1)	0.0192	0.0169	0.0150
	(0.004)***	(0.004)***	(0.004)***
PopDensity	-0.5313	-0.5233	-0.5568
	(0.030)***	(0.029)***	(0.029)***
Lproductivity_a	-0.0031	-0.0031	-0.0036
	(0.002)	(0.002)	(0.002)*
Lproductivity_i	0.0067	0.0057	0.0047
	(0.002)***	(0.002)***	(0.002)***
Lproductivity_s	0.0201	0.0197	0.0193
	(0.004)***	(0.004)***	(0.004)***
Share_a	0.0044	0.0057	0.0046
	(0.001)***	(0.001)***	(0.001)***
Share_i	0.0044	0.0056	0.0053
	(0.001)***	(0.001)***	(0.001)***
Valuehk	0.0444	0.0143	0.0017
	(0.015)***	(0.015)	(0.014)
W*Single(-1)	0.0030	0.0084	0.0058
	(0.001)**	(0.001)***	(0.002)***
W*Network(-1)	0.0055	0.0094	0.0036
	(0.005)	(0.005)*	(0.006)
W*Y	0.8940	0.9065	0.9507
	(0.012)***	(0.012)***	(0.009)***
Spatial specific effects	YES	YES	YES
Observations	1,222	1,222	1,222
R-squared	0.3286	0.224	0.027
Log-likelihood	1688.69	1748.19	1815.05

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Impacts on per capita GDP, the direct and indirect effects of the transport infrastructure explanatory variables

VARIABLES		W_contiguity	W_distance	W_nearestn
Single(-1)	Direct effect	0.0068	0.0087	0.0072
		(0.001)***	(0.001)***	(0.001)***
	Indirect effect	0.0512	0.1078	0.1675
		(0.013)***	(0.017)***	(0.041)***
	Total effect	0.0579	0.1165	0.1747
		(0.014)***	(0.018)***	(0.042)***
Network(-1)	Direct effect	0.0334	0.0313	0.0248
		(0.005)***	(0.005)***	(0.005)***
	Indirect effect	0.1993	0.2487	0.3537
		(0.039)***	(0.047)***	(0.100)***
	Total effect	0.2326	0.2800	0.3785
		(0.043)***	(0.050)***	(0.103)***

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

- Strong evidence of absolute convergence occurring across Spanish provinces
- Result holds when considering conditional convergence, although little impact of investment in transport infrastructure

- The most direct influential role was exerted by the network mode
- The direct impact of the single mode was not proved and can be related to an overcapacity phenomenon given in Spain (excess of supply of transport infrastructure)
- With regards to the spillover effects, negative impact of the single infrastructure and not significant effect of networks

- Positive and highly significant total, direct and indirect effects of network and single investment
- Interesting result: in particular the positive sign of the spatial spillovers is not in line with previous literature on the issue

- Findings also contribute to the debate on the distribution of public resources
- Regional policies in the EU, and particularly in Spain, have been widely promoted by successive governments, using infrastructure investment as the main tool in fostering equality
- However, the large investment in transport infrastructure does not seem to have contributed much to the reduction of regional disparities
- the policy implication that derives directly from the results is that efficiency and demand considerations should be taken into account, in order to achieve the best allocation of public resources and maximize the contribution of investment in infrastructure on economic growth