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Suburbanization and highways in Spain when the Romans and the Bourbons still shape its cities

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ABSTRACT

We estimate the effects of highways on the suburbanization of Spanish cities. Based on Spain's historical roads – the almost 2000 years old Roman roads and the 1760 Bourbon roads –, we rely on an instrumental variables (IV) strategy because of the endogeneity of highway provision. Our results show that, first, each highway emanating from central cities caused an 8–9% decline in central city population between 1960 and 2011. Second, each highway ray fostered a 20% population growth in the suburbs, in particular in suburban municipalities where ramps were located. Finally, we confirm the increasing role of highways on shaping urban form: each additional kilometer closer to the nearest highway ramp increased municipal density growth by an 8%.

1. Introduction

Over the last fifty years Spain has dedicated huge amounts of money to fund public investment in the highway system. These efforts mean that today Spain has the longest highway network in Europe and the fifth in the world. Clearly, this scale of investment has had many implications for the country's economy over the following decades. One of these implications is related to the changes in the urban form of its metropolitan areas. What impact did highways have on the suburbanization of Spain's cities between 1960 and 2011? Did they cause the decline of central city population? Did they foster suburban population growth? Did they shape the intrametropolitan pattern of residential location?

Spain's highways have ancient origins and we use this history to investigate the above questions. In particular, we estimate the relationship between the growth in population and highways in three separate equations – one for central cities, one for the suburbs, and one for the overall urban spatial structure. Because of the endogeneity of highway provision, we use the old Roman roads and the 1760 Bourbon roads as sources of exogenous variation. The Roman roads formed a mesh-like network designed to accomplish military and commercial goals, and were the main road infrastructure in Spain for nearly 1700 years. The 1760 Bourbon roads were funded by the new Bourbon dynasty to satisfy the needs of the new absolutist state: the road network was dramatically changed by abandoning most of the old Roman roads and building a new radial system of post roads centered on Madrid. Because these historical roads were not placed randomly and some of the factors that influenced their location may have also influenced modern highways, instrument exogeneity hinges on satisfying the exclusion restriction by controlling for physical geography and history.

We find that each highway contributed to an 8–9% decline in central city population between 1960 and 2011. This result is only related to highway rays (i.e., emanating from central cities), and not to the expansion of the highway network in the suburbs. We also find that each of these highway rays fostered a 20% population growth in the suburbs, in particular in suburban municipalities where highway ramps were located. As predicted by theory, this

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ramp effect is larger in more distant suburban municipalities (31%) than the ones close to the center (18%). Finally, we confirm the increasing role of highways on the intrametropolitan patterns of residential location: each additional kilometer closer to the nearest highway ramp increased municipal density growth by an 8%.

Our findings are relevant for three reasons. First, they provide interesting evidence that was needed for Europe. As far as we know, there are only two comparable papers studying the effect of highways on suburbanization in terms of central city population decline: the pioneering paper by Baum-Snow (2007a) for US metropolitan areas, and Baum-Snow et al.'s (2014) analysis for China's prefectures. For the case of Spain, we find similar results to the ones for the US and China: highways cause central city population decline. As in Baum-Snow et al. (2014), only highways connecting central cities to the suburbs (and not the overall suburban network) cause suburbanization. In other words, despite differences in city population size and density, land-use planning, or the use of public transit between US, Chinese and European cities, our results show that population suburbanization is also an ongoing phenomenon in Europe and that it is also influenced by the construction and the intrametropolitan location of highways.

Second, some of our findings are new in the literature and some of them verify theoretical predictions. While the above papers only estimate the effect of highways on central city population, we also study the effect on the suburbs and on the overall urban spatial structure. As above mentioned, we find that highways also foster suburban population growth, in particular in municipalities with ramps. These ramp effects are heterogeneous and increase with distance to the central business district (CBD). Our findings also confirm that highways influence the spatial pattern of suburbanization by spreading population out along these highways.

Finally, although the use of historical instruments is not new in the literature, we are among the first to use 2000 years old instruments based on the whole Roman road network in Hispania (Spain) and 250 years old instruments based on the whole 1760 Bourbon network in the absolutist Spain. We provide empirical evidence that both the Roman and the Bourbon roads still shape Spanish cities by influencing the construction and location of modern highways.

Our study is also related to recent empirical literature that has examined other aspects of transportation infrastructure and dealt with the aforementioned simultaneity problem. Sharing our intrametropolitan approach, Baum-Snow (2010) investigates the effect of highway improvements on commuting patterns within and between central cities and suburbs. At a county level, Michaels (2008) analyzes the relation between highways and workers' earnings, and Jiwattanakulpaisarn et al. (2009) study the effect of highway infrastructure investment on employment growth. Duranton and Turner (2011) and Hsu and Zhang (2014) provide intermetropolitan evidence for the effect of highway improvements on congestion in the US and Japan, respectively. Duranton and Turner (2012) find that the stock of highways has a positive impact on urban growth in US metropolitan areas. In the development economic literature there are some recent papers analyzing the effect of infrastructures on different city outcomes. Banerjee et al. (2012) examine the effects of access to transportation networks on economic outcomes in Chinese counties. They find that proximity to these networks have a moderate positive effect on per capita GDP levels but no effect on per capita GDP growth. Faber (2012) studies the impact of the Chinese National Trunk Highway System on city growth. Finally, Donaldson (forthcoming) analyzes the incidence of Indian railroads in late 19th and early 20th century and finds big effects on trade and welfare.

The rest of our investigation is organized in six more sections. In Section 2, we summarize the main characteristics of the Roman roads, the 1760 Bourbon roads, and modern highways in Spain. In Section 3, we analyze whether these two historical networks still influence the construction and location of modern highways. In Section 4, we study whether highways cause central city population decline and how. In Section 5, we explore whether highways foster suburban growth and through which type of highways. In Section 6, we investigate whether highways shape cities causing changes in their urban spatial structure. Finally, we present our main conclusions in Section 7.

2. From Hispania's Roman roads to Spain's modern highways

2.1. All roads lead to Rome

The origins of the modern European road infrastructure can be traced to the Roman roads. While pre-Roman peoples built short distance roads to provide mobility within and between local areas, the Romans were the first to built an extensive and sophisticated network of paved and crowned roads. As a whole, they built over 85,000 km of main roads, which radiated from Rome and connected the different parts of the Empire, from Britain to Syria (O'Flaherty, 1996).

The Romans first landed in Iberia in 218 BC to fight against the Carthaginians (Second Punic War), but they still took another two centuries to bring the entire peninsula under their control. Caesar Augustus completed the conquest of Iberia, then Hispania, after the Cantabrian wars in 19 BC. In common with other European countries, road construction in Hispania responded to economic and administrative needs. First, roads were built to promote Rome's military goals, the conquest and defense of Hispania. These strategic roads passed through mountains and avoided valleys. Later, during the Pax Romana, some of the military roads were abandoned, others were modified as engineers found less steep and faster routes, and new ones were built. As a result, Hispania's accessibility was improved and its administrative and commercial relations within the province and with the rest of the Roman Empire were expanded.

The Roman road system in Hispania (Fig. 1) was based on nearly 7000 km of main roads (10,500 km including local roads) forming a decentralized mesh-like network. According to Carreras and Soto (2010), there were four main routes. First, the Via Augusta (also known as Via Herculea) crossed all Hispania from the Pyrenees in the northeast to Gades (Cádiz) in the south. It ran 1500 km along the Mediterranean coast linking cities such as Tarraco (Tarragona), Dertosa (Tortosa), Valentia (Valencia) and Cartago Nova (Cartagena) and then inland through Granada, Corduba (Córdoba), Astig (Écija) and Hispalis (Sevilla) to Gades (Cádiz). Second, the Vía de la Plata (900 km) ran vertically from south to north, from Gades (Cádiz), via Hispalis (Sevilla) and Emerita Augusta (Mérida) to the gold mines of Las Médulas, close to Asturica (Astorga). Third, it was also important the route that linked northwest Hispania with the Ebro valley and the Mediterranian basin in the northeast. This route ran horizontally 1000 km from Braccara Augusta (Braga in Portugal) and Lucus Augusti (Lugo) to Caesaragusta (Zaragoza) and Tarraco (Tarragona). Finally, less important was the route (700 km) that diagonally linked Caesaragusta (Zaragoza) in the northeast with Emerita Augusta (Mérida) in the southwest, through Toletum (Toledo) in the center of Hispania.

2.2. The new Bourbon dynasty and the new roads

For centuries, the Roman roads were the ones used in Spain. First, by the Visigoths after the decline and fall of the Roman