Regional Studies

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/cres20

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To cite this article: Jose I. Castillo-Manzano, Mercedes Castro-Nuño, Lourdes Lopez-Valpuesta & Jesús Boby (2022) Centralization versus decentralization of traffic law enforcement governance in Spain, Regional Studies, 56:11, 1976-1988, DOI: 10.1080/00343404.2021.2020743

To link to this article: https://doi.org/10.1080/00343404.2021.2020743

REGIONAL STUDIES
2022, VOL. 56, NO. 11, 1976–1988
https://doi.org/10.1080/00343404.2021.2020743

Centralization versus decentralization of traffic law enforcement governance in Spain

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ABSTRACT

The current paper deals with the debate over centralization versus decentralization in road safety management, and specifically in traffic law enforcement. We address the case study of Spain, where a single traffic law acquis is enforced by two systems: road policing decentralized for some regions and national road policing for all others. Our econometric findings reveal that the Spanish regions with centralized traffic policing present better safety figures, which might be useful for reinforcing the coordinated performance of road safety policy in other traditionally decentralized countries. Furthermore, our evidence indicates that cautious analyses have to be carried out on a case-by-case basis.

KEYWORDS

road safety; law enforcement; traffic police management; centralization; decentralization; multilevel governance

JEL K42, L91, R41

HISTORY Received 15 July 2020; in revised form 1 December 2021

INTRODUCTION

Decentralization and the multilevel management of public administration is a growing trend in most developed countries (Koprić et al., 2017; Steiner et al., 2018). According to the World Bank (1999), decentralization can be defined as the delegation of political, fiscal and administrative powers to subnational levels. Scientific research into decentralization was popularized in the second half of the 20th century with Oates' (1972) Decentralization Theorem, which outlined a framework to identify the appropriate sharing of national, regional and local public services. As a consequence, vast numbers of scholars have addressed the impact of decentralizing public services, exploring approaches, models and effectiveness. Nevertheless, the debate is still open because there are outcomes supporting both centralization and decentralization depending on the specific policy area (Kuhlmann & Wayenberg, 2016) as each offers potential advantages and disadvantages.

First, decentralization can be justified by the Theory of Fiscal Federalism, which assumes that decentralized government is more responsive to citizen preferences and, therefore, more effective at solving public problems (Oates, 1972). In fact, a great deal of evidence shows that decentralization enables a more efficient service to be provided to citizens, as well as increased public participation and accountability (Kuhlmann & Wayenberg, 2016) in both developing and developed countries. In this context, it has even been demonstrated that decentralization may lead to a reduction in inequalities between regions (Ezcurra & Rodríguez-Pose, 2013; Kyriacou et al., 2017). Effectiveness is assumed to increase due to regional and local governments' ability to better adapt to specific local needs (Balaguer-Coll et al., 2010) and respond more quickly to demands on account of their smaller size.

However, there is also empirical evidence to the contrary: for certain authors, decentralization may result in the provision of poorer services due to access to personnel

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Supplemental data for this article can be accessed at https://doi.org/10.1080/00343404.2021.2020743

with lower competency levels and reduced expertise, fewer monitoring and control artifacts, and the more complex coordination and implementation of reforms (Segal, 1997; Treisman, 2002), which, therefore, reduces the effectiveness and quality of the public services offered. In this regard, a centralized administration could create economies of scale in which fixed costs are not repeated, whereas multiple fixed costs can exist when administration is decentralized (Steiner et al., 2018). Furthermore, competition between regional and local governments can lead to other risks such as corruption or control by local political elites (Cai & Treisman, 2004), especially in developing countries, where it can even result in slower economic development (Davoodi & Zou, 1998).

The debate on the most appropriate level of distribution of public administration competencies is also ongoing in the area of social care services, with the specific governance level chosen for each type of public service according to the characteristics of the specific country or region (Aslim & Neyapti, 2017). Some examples of public services that are frequently decentralized are education (Mwinjuma et al., 2015), healthcare (Jiménez-Rubio & García-Gómez, 2017), or justice and security (McCluskey et al., 2014).

Police system services may also be devolved to different tiers of government to achieve the best outcomes (Lowatcharin & Stallmann, 2019) and this is the case of the current paper's specific object of study: road traffic policing. Traffic law enforcement management is decentralized in several European countries such as Belgium, Germany, the UK, Sweden and the Netherlands, with the responsibility to implement targets and strategies shared between the central and regional authorities (SafetyNet, 2009).

In general terms, it has been empirically demonstrated that law enforcement is one of the most effective strategies for changing driver behaviour (Adler et al., 2012), especially regarding excessive speeding (Aarts & Van Schagen, 2006), non-use of seat belts (Acosta-Rodriguez et al., 2020), drugs driving (Penning et al., 2010) and drink driving (Stringer, 2019). Together with engineering and education, police enforcement has been demonstrated to be a traditional approach to achieving reductions in the prevalence and incidence of traffic accidents (Stanojević et al., 2013) by encouraging road users to comply with basic traffic rules and regulations and deterring traffic violations (Feng et al., 2020), specifically on interurban roads (Delavary Foroutaghe et al., 2020), and for Spain (Castillo-Manzano et al., 2019), both in the case study and on the kind of road analysed in the current paper.

This broad treatment of the effectiveness of traffic police enforcement on road safety outcomes fully justifies the appropriateness of our analysis as we study a novel topic based on the safety impact of the decentralization of traffic law enforcement governance on interurban roads in a case study of Spain, a country which is an outstanding illustration of decentralization in general (Moreno, 2002).

Based on the previous literature that addresses the decentralization of public policies (Kuhlmann & Wayenberg, 2016), it can be argued that the level of decentralization of the traffic police in Spain could have either a positive or negative influence on road traffic safety. As stated above, the smaller size of a regional police force and its greater proximity to citizens, which allows it to better adapt to the area's specific culture, related behaviours and geography, should enable it to be more agile (Lowatcharin & Stallmann, 2019). However, the national approach should give the police access to greater assets and resources and a higher level of expertise and enable them to promote the use of management best practices (in the sense of the so-called 'economies of scale'), among other things (McCluskey et al., 2014).

Unfortunately, there are still no world-generalizable studies in the literature on comparative levels of traffic policing. The purpose of our research is, therefore, to explore the impact of the coexistence of two tiers of traffic police governance on road traffic safety and to identify the sign of the impact (should one exist) for the case of Spain, using data for Eurostat statistical territorial classification NUTS-3 regions (considered to be the provinces in Spain) and a 16-year period (2003–18).

This research paper's analysis of the state of the art makes two new contributions to the scientific literature. First, it adds a new field of study to the public administration decentralization debate, specifically on traffic law enforcement, which, to our knowledge, has not been empirically assessed previously, and offers new practical evidence. Second, it provides the safety literature with a new analysis of the impact that the decentralization of traffic police enforcement has had in Spain in terms of traffic accident and fatality figures for interurban roads.

In view of this background, the remainder of the paper is structured as follows. The next section explains the Spanish context for the decentralization process and road safety. The third section includes the methodology applied and the variables and panel data used for the analysis. The fourth section gives the results of the econometric analysis and a discussion, including a comparison with other scientific bibliography. Finally, the fifth section presents the main conclusions of the research. There is also the supplemental data online.

TRAFFIC POLICE DECENTRALIZATION PROCESS AND ROAD SAFETY IN SPAIN

Territorially, Spain is organized into 17 Eurostat NUTS-2 regions (according to Eurostat terminology) (i.e., a first-level political and administrative division per the Spanish Constitution of 1978), which is arranged around the framework of a 'State of Autonomies' (Moreno, 2002), and two North African cities (Ceuta and Melilla), which have also been granted the status of self-governed territories. Each NUTS-2 region is, in turn, formed of one or several NUTS-3 regions (in Eurostat terminology, which are known as provinces in Spain), with a total of 50 in all.

Administratively, Spain is not a federation but a decentralized unitary state (Colomer, 1998), with the widespread roll-out of devolution of governance to regional governments throughout Spain's democratic era, since the 1978 Constitution came into force (Balaguer-Coll et al., 2010), until the current situation was reached in which approximately 80% of the public budget is directly managed by regional and local administrations (Spanish Ministry of Finance data). This decentralization process has not been homogeneous (Martí-Costa et al., 2017), that is, some regions have higher levels of decentralization than others in many services and depending on policy areas considered.

For example, nowadays, while the process of transferring full competencies in social welfare issues such as healthcare (Costa-Font & Rico, 2006; Costa-Font & Turati, 2018) or education (Alegre, 2010; Salinas & Solé-Ollé, 2018) has been completed, conversely, traffic and road safety management has followed a different decentralization model and pace. In this regard, the 1978 Spanish Constitution stated that the state reserves for itself some exclusive legal and executive functions regarding traffic and the circulation of motor vehicles. However, based on some historical antecedents, some subsequent legislation expressly recognized that the Basque Country (1982) and Catalonia (1997) regions should exercise full executive competencies for the supervision and control of national traffic regulations on interurban roads in their respective territories. In other words, while the devolution process in areas such as education and health has been rolled out during a period of over two decades to the benefit of the regions and only recently concluded, with all the regions whose autonomy is recognized in the Constitution being given competencies in these areas, in the case of traffic management, which had received previous recognition, it has been reduced to the issues analysed in the present paper (supervision of compliance with the regulations in force) and then, only in some specific regions.

As a consequence, traffic police management is centralized for most Spanish regions and self-governed in only a few. Three levels of decentralization exist (Table 1):

- *Centralized traffic police*. This is the most common approach with road traffic controlled by the Agrupación de Tráfico de la Guardia Civil (ATGC – Civil Guard Traffic Group).
- *Fully decentralized policing*. In the regions of Catalonia and the Basque Country, the policing of road traffic comes under the full authority of the regional governments, with road traffic controlled by the Mossos d'Esquadra and Ertzaintza, respectively.
- *Partially decentralized policing*. In the region of Navarre, road traffic policing is partially decentralized, with the ATGC sharing responsibility with the regional police (Policía Foral, in Spanish).

In Spain, local/municipal police departments are in charge of traffic enforcement on urban roads, while the national or regional traffic police are responsible for interurban roads.

It is also important to highlight that the traffic legal acquis is the same for all the regions in the country. Road safety strategies typically included in the literature, such as alcohol consumption limits (Krüger, 2013), the implementation of a points-based driving licence system (Rodríguez-López et al., 2016), and the speed limits in force (Lloyd et al., 2015) are implemented in all the Spanish regions and so do not contribute to any differences in safety figures.

Focusing on safety figures, recorded traffic accidents have improved significantly in Spain since the beginning of the 21st century, to the extent that a 70.9% reduction has been achieved in the period 2000–13) (Organisation for Economic Co-operation and Development (OECD), 2015). It can, therefore, be considered a country to learn from (Wegman, 2017), particularly in the European context (Castillo-Manzano et al., 2014a, 2015).

By way of example, Table 2 shows a comparison of traffic fatality figures in Spain and in the EU-28 in which the first and last years of the time series analysed in the present paper have been taken as references. As can be observed, although both the number and rate (per 100,000 inhabitants) of fatalities were high in Spain in 2003, 15 years later, in 2018, the figures had improved significantly.

When the data for Spain are broken down by NUTS-3 region for the case of interurban roads, the same positive evolution in the figures can be seen in the case of both fatalities and accidents in NUTS-3 and with centralized and decentralized traffic enforcement (Figure 1; and see Table A1 in Appendix A in the supplemental data online).

These data have turned Spain into an example of success in road safety policies in the EU framework (Castillo-Manzano et al., 2014c), including the implementation of points system-based driving licences (Gras et al., 2014), innovative mass-media public advertising campaigns (Nicolás Ojeda et al., 2015) and hardening punitive strategies by reforming the Penal Code (Castillo-Manzano et al., 2011).

In this context of reforms aimed at improving road safety, we consider that the decentralization of traffic enforcement in some Spanish regions should be studied in depth in order to be able to assess its effects on road accidents and fatalities.

EMPIRICAL FRAMEWORK: DATA, VARIABLES AND METHODOLOGY

Original panel data were constructed ad hoc using available official data for a sample based on the 50 Spanish NUTS-3 regions (provinces). The study period is from 2003 to 2018. The beginning of this period corresponds to the coming into force of Royal Decree-Law No. 1428/2003, which established the current General Driving Regulation in Spain, while 2018 was the most recent year for which we have found a complete dataset for the regions and variables considered. This time period also allows an analysis of the influence of external macroeconomic, social

Table 1. Traffic police decentralization process in Spain.

Spanish NUTS-2 regions	Spanish NUTS-3 regions (provinces)	Type of governance (year)	Legislation	Traffic police departments
Basque Country	Alava	Fully decentralized (1982)	Royal Decree 3256/1982 of 15 October	Ertzaintza
	Gipuzkoa			
	Vizcaya			
Catalonia	Barcelona	Fully decentralized (2000)	Organic Law 6/1997 of 15 December	Mossos d'Esquadra
	Girona	Fully decentralized (1998)		
	Lleida	Fully decentralized (1999)		
	Tarragona	Fully decentralized (2000)		
Navarre	Navarre	Partially decentralized	Organic Law on the Reintegration and Improvement of the Navarre Regional Regime, 1982	Navarre Police Force (Policía Foral) and Civil Guard Traffic Group

Source: Authors.

and political changes that have impacted road traffic safety.

Two models have been estimated using both traffic accidents and fatalities on interurban roads as the endogenous variables and a set of exogenous variables detailed in Table 3. Accidents and fatalities on urban roads (in municipalities) have been excluded from the analysis as, in Spain, road traffic safety on these roads comes under the responsibility of the local police (which, as stated above, is fully decentralized).

The panel data have been econometrically treated with the STATA package using two econometric models that take NUTS-3 region (province) i during period t:[1]

$$\ln(E[Y_{it}]) = \alpha + \zeta \cdot Decentralization_{it} \cdot Year_t + \beta_k X_{it} + \nu_t Year_t + \delta_i NUTS3 - Region_i + \varepsilon_{it}, \quad (1)$$

where Y_{it} are the endogenous road safety variables, that is, the number of road traffic accidents/road traffic fatalities on interurban roads (within a period of 30 days following the accident, in accordance with the Vienna Convention). As explained in the following section, total figures have been chosen instead of per capita variables, as the total number of drivers was used as the exposure variable (Usman et al., 2011). $Decentralization_{it}$ is a dummy variable used to capture the decentralization of traffic police enforcement governance for some Spanish regions. This dummy variable takes a value of 1 if traffic policing is fully/partially decentralized in the region, and 0 if traffic policing depends on the central authorities. We include the decentralization variable corrected by time trend to avoid collinearity with regional fixed effects. Note that road traffic enforcement decentralization is constant for the entire assessment period, which might represent a limitation for our analysis. This is an adaptation of difference-in-differences (DiD) techniques in which we have introduced the intervention effect over time. The variable $Decentralization_{it} \cdot Year_t$ is called 'Decentralized trend' in the corresponding tables. X_{it} are control variables that measure: (1) Economic and healthcare issues, more specifically the unemployment rate and hospital density, respectively. The previous literature broadly demonstrates pro-cyclical behaviour between the economic situation and road traffic safety, so the unemployment rate is expected to show a negative sign with road traffic safety outcomes (as in Scuffham & Langley, 2002). Hospital density is included in the model as a proxy of healthcare system capacity. It is, therefore, estimated a priori that hospital density and traffic fatalities will show a negative correlation, following earlier studies such as Truong et al. (2016) and Castillo-Manzano et al. (2014b). (2) Demographic parameters related to the average age of the population and the ratio of capital's population in the total regional population. The average age variable aims to model the difference in driving behaviours for different

Table 2. People killed in road accidents (EU-28 versus Spain).

	Number			Rate (number per 100,000 persons)		
	2003	2018	%	2003	2018	%
EU-28	50,989	25,178	−50.62%	10.4	4.9	−52.88%
Spain	5373	1806	−66.39%	12.7	3.9	−69.29%

Source: Eurostat.

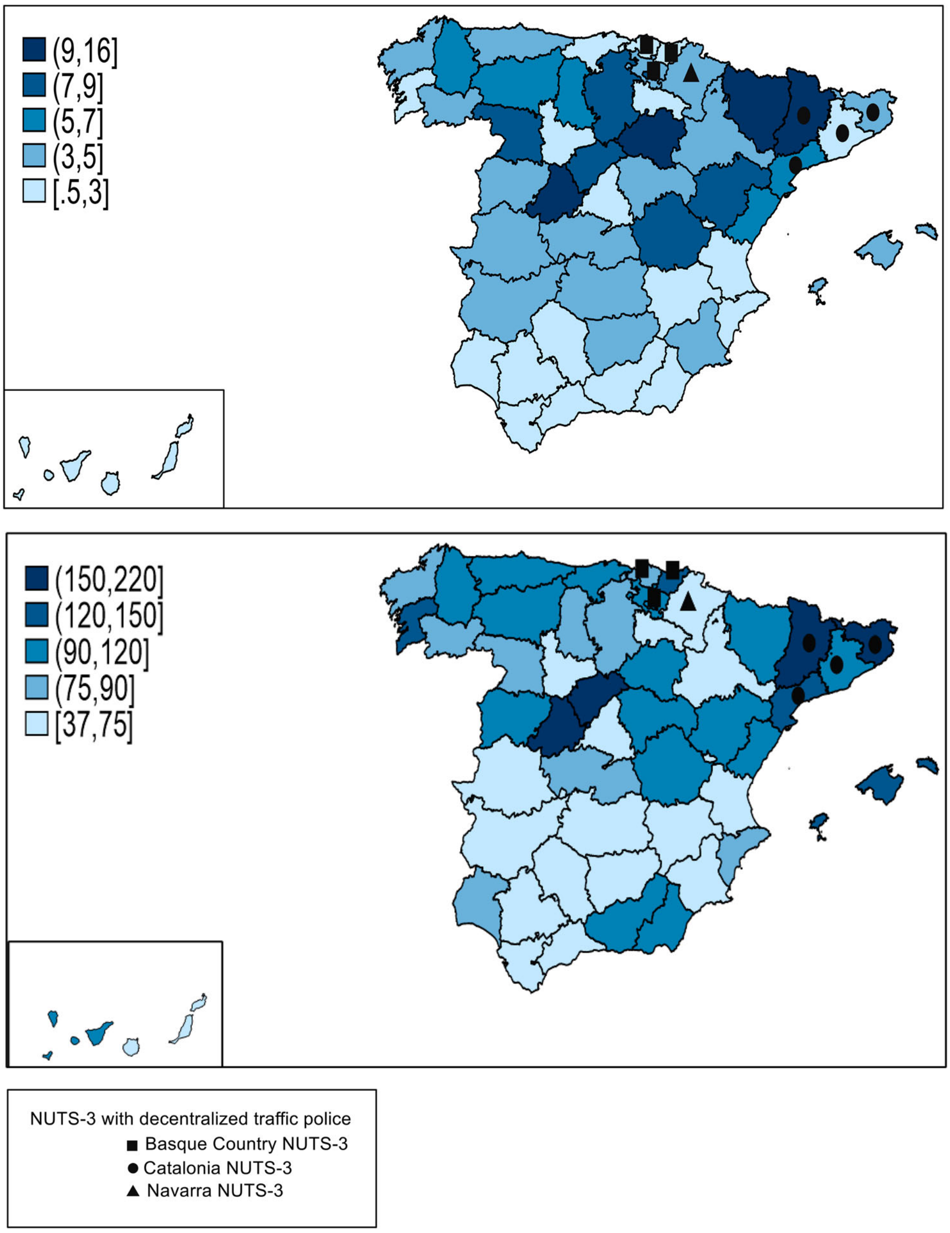

Figure 1. Fatality rate (a) and accident rate (b) per 100,000 persons on Spanish interurban roads in NUTS-3 regions in 2018. Sources: Authors from the Spanish General Traffic Directorate (DGT) and National Statistics Institute (INE).

ages. According to the existing scientific literature (Prat et al., 2015), the youngest drivers present more reckless driving behaviour with more frequent consumption of drugs and alcohol while driving, which may contribute by increasing the likelihood and severity of accidents. However, elderly drivers normally present deteriorated physical and cognitive capabilities that can lead to an increase in both accidents and mortality (Li et al., 2003). The ratio of the capital's population in the total population is a proxy of population concentration. There is no consensus on the influence of this variable on road traffic safety: in some cases, higher population concentration is expected to lead to an increase in accidents (Castro-Nuño et al., 2018), which can be explained by an increase in travel from metropolitan areas to access essential services mostly located in the capital city; but better road safety has also been found in other cases (Tolón-Becerra et al., 2013) as a result of a reduction in commuting in regions with a higher population concentration. (3) Mobility and infrastructure parameters, specifically, the motorization rate and the density of highways on all roads. The motorization rate is used as a proxy of the exposure risk factor; thus, it is initially expected that a higher stock of vehicles and a greater use made of them may lead to higher accident and fatality rates (Noble et al., 2015). A negative relationship is also initially expected between the accident and fatalities and highway ratio, as better infrastructure is shown to improve road traffic safety (Aparicio-Izquierdo et al., 2013; Sánchez-González et al., 2018). Finally, the total number of tourists visiting the region is included as a proxy of exposure and risk behaviours. Tourism has previously been demonstrated to increase traffic congestion

Table 3. Variables used in the empirical analysis.

Variable	Description	Source
Accidents on interurban roads	Traffic accidents on interurban roads in each of the Spanish NUTS-3 regions	Spanish General Traffic Directorate Yearbook (https://www.dgt.es/menusecundario/dgt-en-cifras/dgt-en-cifras-resultados/?tema=accidentes-de-trafico&categoria=informe-anual&pag=1&order=DESC)
Fatalities on interurban roads	Fatalities within 30 days of the accident on interurban roads in each of the Spanish NUTS-3 regions	Spanish General Traffic Directorate Yearbook (https://www.dgt.es/menusecundario/dgt-en-cifras/dgt-en-cifras-resultados/?tema=accidentes-de-trafico&categoria=informe-anual&pag=1&order=DESC)
Decentralization	Dummy variable equal to 1 if traffic policing is partially or fully decentralized in the region; 0 otherwise	Spanish Ministry of Internal Affairs (http://www.interior.gob.es/en/portada)
Unemployment rate	Unemployment rate during the fourth quarter of the period in each of the Spanish NUTS-3 regions	Spanish National Statistics Institute (INE) (https://www.ine.es/en/index.htm)
Hospital density	Number of hospitals per 1000 km^2 in each of the Spanish NUTS-3 regions	National Hospitals Catalog – Spanish Ministry of Health, Consumer Affairs, and Social Welfare (https://www.mscbs.gob.es/en/ciudadanos/prestaciones/centrosServiciosSNS/hospitales/home.htm)
Average age	Average age of the population living in each of the Spanish NUTS-3 regions as of 1 January	INE (https://www.ine.es/en/index.htm)
Ratio of population in capital city	Ratio of the population living in the main city in the region with respect to the total population in each of the Spanish NUTS-3 regions	INE (https://www.ine.es/en/index.htm)
Motorization rate	Vehicles per 1000 inhabitants in each of the Spanish NUTS-3 regions	INE (https://www.ine.es/en/index.htm)
Highways ratio	Ratio between the total length of highways and the total length of all types of roads in each of the Spanish NUTS-3 regions	Spanish Ministry of Transport, Mobility, and Urban Agenda (https://www.mitma.gob.es/carreteras/catalogo-y-evolucion-de-la-red-de-carreteras)
Tourists	Total number of tourists who stayed at least one night in each of the Spanish NUTS-3 regions	INE
Precipitation	Average monthly rainfall by region and year in each of the Spanish NUTS-3 regions	Spanish State Weather Agency (http://www.aemet.es/en/eltiempo/observacion/ultimosdatos?k=esp&datos=img&w=2)
Per capita GDP	Gross domestic product per inhabitant in each of the Spanish NUTS-3 regions	INE
Population density	Million inhabitants per km^2 in each of the Spanish NUTS-3 regions	Eurostat (https://ec.europa.eu/eurostat/databrowser/view/tps00003/default/table?lang=en)
Driver census (exposure variable)	Valid driving licences in each of the Spanish NUTS-3 regions	Spanish General Traffic Directorate Yearbook (https://www.dgt.es/menusecundario/dgt-en-cifras/dgt-en-cifras-resultados/?tema=conductores|accidentes-de-trafico&categoria=informe-anual&pag=1&order=DESC)

and to be associated with an increase in alcohol consumption and other imprudent behaviour, so it is initially expected to contribute to a deterioration in road traffic safety (Castillo-Manzano et al., 2020). Meteorological variables through the volume of rainfall. There is empirical evidence that indicates that weather conditions affect road traffic safety; specifically, we expect an unfavourable impact of rainfall on the road traffic safety variables (Usman et al., 2011). To capture evolution over time, first, a time trend is used. An evolution of the specification with time fixed effects is included in Table A3 in Appendix A in the supplemental data online as a robustness check. $NUTS\text{-}3Region_{it}$ are fixed effects per region according to the outcomes of the Hausman tests (Table 5). Regional fixed effects are included in the model to quantify all the specific characteristics of each NUTS-3 region not measured by the remaining variables. The inclusion of regional fixed effects is a common approach when working with panel data in road traffic research projects (Toffolutti & Suhrcke, 2014). Finally, ε_{it} is the mean zero random error.

Table 3 describes the variables considered and the sources from which they have been taken. Table 4 gives the units and the descriptive statistics.

Given the nature of panel data, we have used a fixed effects Poisson model for our estimations. Pearson goodness-of-fit chi-squared tests have been calculated for the individual models for each NUTS-3 region (province). The null hypothesis of NUTS-3 region-level over-dispersion in both endogenous variables is rejected in all cases, whereby the Poisson is a good fit in these cases. In addition, the standard deviation is lower than the mean at the NUTS-3 region level for both endogenous variables. The only possible over-dispersion comes from between-NUTS-3 region differences and has been controlled by using robust standard errors clustered by NUTS-3 region as in Wu et al. (2014). Results are not included here for the sake of simplicity but are available from the authors upon request.

RESULTS AND DISCUSSION

Table A2 in Appendix A in the supplemental data online shows the correlation matrix of the variables used in the analysis. As can be observed, there are no high correlations among the exogenous variables used, which implies that there are no multicollinearity problems.

Table 5 gives the estimation results for the model proposed in the previous section. A normality test (Shapiro–Wilk) has been performed on the endogenous variables. The endogenous variables cannot be inferred to follow a

Table 4. Variables: descriptive statistics.

Variable	Unit of measurement	Observations	Mean	SD	Minimum	Maximum
Accidents on interurban roads	Annual number of road accidents with casualties	800	808.79	772.35	83.00	5622.00
Fatalities on interurban roads	Annual number of people killed in a traffic accident	800	44.56	34.19	4.00	241.00
Decentralization	–	800	0.16	0.37	0.00	1.00
Unemployment rate	Annual % of unemployed people per total labour force	800	16.49	7.96	2.87	42.34
Hospital density	Annual number of hospitals per surface area (km^2)	800	0.059	0.264	0.000	2.186
Average age	Years	800	42.61	2.85	36.29	50.49
Ratio of population in capital city	Ratio	800	0.32	0.13	0.09	0.76
Motorization rate	Vehicles per 1000 inhabitants	800	0.678	0.080	0.072	0.957
Highways ratio	Ratio	800	0.07	0.08	0.004	1.192
Tourists	Annual millions of persons	800	0.905	0.868	0.121	6.560
Precipitation	mm/100	800	486.50	305.16	4.00	1867.90
Per capita GDP	€, current prices	800	20,243.91	4898.90	10,111.00	37,675.00
Population density	Million inhabitants/km^2	800	131.62	173.49	8.58	842.89
Driver census	Annual number of drivers	800	506,112.40	589,328.10	50,172.00	3,520,477.00
Year		800	2010.50	4.61	2003.00	2018.00

Table 5. Estimation results (panel data model, population averaged Poisson with fixed effects).

Endogenous variables/ exogenous variables	(I) Fatalities on interurban roads	(II) Accidents on interurban roads
Decentralized trend	0.01277**	0.05010***
	(0.0063)	(0.0192)
Unemployment rate	−0.02462***	−0.00798***
	(0.0022)	(0.0019)
Hospital density	−0.2194***	−0.1484***
	(0.0591)	(0.0356)
Average age	0.05492***	0.04624
	(0.0198)	(0.0532)
Ratio of population in capital city	2.1736**	−0.6156*
	(0.9587)	(0.3615)
Motorization rate	−0.4431**	−0.0650
	(0.2075)	(0.1697)
Highways ratio	−0.1157**	−0.00485
	(0.0589)	(0.0165)
Tourists	−0.0595*	0.1503*
	(0.0317)	(0.0797)
Precipitation	0.0972**	0.0193
	(0.0391)	(0.0212)
Year	−0.0994***	−0.0539***
	(0.00543)	(0.0213)
Time fixed effects	No	No
Regional fixed effects	Yes	Yes
AR(1)	Yes	Yes
Modified Wald test for groupwise heteroscedasticity	629.86***	4903.23***
Hausman test Chi^2	26.39***	88.29***
Levin–Liu test adjusted *t**	−1.5752*	−2.7598***
Shapiro–Wilk test for normality *W*	0.8277***	0.6848***
Joint significance test (Wald Chi^2)	7462.85***	15,883.73***

Note: Standard errors are shown in parentheses, robust to heteroscedasticity and grouped by NUTS-3 region. Regressions specify a within-group AR(1) correlation structure for panels. Driver census used as an exposure variable.
Statistical significance at 1% (***), 5% (**) and 10% (*).

normal distribution, which also indicates that a count data distribution seems to be a good choice.

Estimations can present problems of heteroscedasticity and temporal autocorrelation in the error term if they are not correctly treated. The modified Wald test for groupwise heteroscedasticity is given in Table 5 and demonstrates that model estimations without any corrections may be affected by this issue. The Levin–Lin–Chu test is also performed on the endogenous variables and supports the selection of a stationary model (Levin et al., 2002). In addition, the entire model is significant at 1% as shown by Wald chi-squared statistics.

Finally, some modifications to the models included in Table 5 are included as robustness checks in Table A3 in Appendix A in the supplemental data online:

- Models III and IV introduce time fixed effects into the original specification.
- Models V and VI remove one NUTS-3 region (Navarre) where traffic law enforcement is partially decentralized to test whether this special situation leads to any bias in the results.
- Models VII and VIII introduce new variables into model as proxies of exposure and activity to analyse the influence that they might have.
- Models IX and X add differentiated slopes for each NUTS-3 region to test whether these individual trends should be added to the original model.
- Models XI and XII introduce a general pooled ordinary least squares (OLS) specification.

Results of multivariate correlations show that NUTS-3 regions where traffic law enforcement is decentralized (exercised by the regional traffic police department) record, *ceteris paribus*, higher numbers of interurban traffic accidents and fatalities compared with those where traffic enforcement governance is centralized under the national traffic police force.

This finding is statistically significant at 1% in most cases and is found in both the original models and the robustness checks (with the only exceptions of models X and XI in Table A3 in Appendix A in the supplemental data online). This suggests that, in the Spanish case and during the analysed period, the ATGC (Civil Guard) has been more effective at preventing crashes than the regional police forces (Mossos d'Esquadra, Ertzaintza and Policía Foral) when applying the same traffic laws and considering the typical socio-economic, mobility and environmental variables that may impact on road traffic safety as control variables.

This outcome is in line with the previous literature that has analysed the impact of decentralization on other public policies (Segal, 1997), and demonstrates, in this case, that a centralized administration could lead to positive results as it enables access to larger quantities of better resources and methods, minimizes competition between administrations, and reinforces monitoring and control practices as a consequence of the so-called 'economies of scale' that can also be found in the centralization of other public policy areas (Karjalainen, 2011). This would also all be reinforced by the Spanish interurban road network's characteristic 'network economies' as analysed in the current paper, because it serves all road users who circulate in Spanish territory (both transit from one region to another and continuous transit generated by tourist movements or the so-called Paso del Estrecho[2] during the summer months), irrespective of the point of origin. There is no doubt that this enhances the role of the centralized management of police enforcement and surveillance carried out by the Civil Guard on the central highway network.

Having analysed the effect of decentralization, the outcomes for the rest of the variables used in the models are described below.

First, both road traffic accidents and fatalities show a statistically significant negative relationship with the unemployment rate (a lower unemployment rate, i.e., an economic growth cycle, implies worse road safety). This is in line with the findings of Sánchez-González et al. (2018) for the Spanish case and what is frequently stated by the scientific literature in other countries (Bishai et al., 2006).

Second, a negative relationship has been found between fatalities and hospital density. This confirms the favourable influence that healthcare expenditure and related healthcare variables have on road traffic safety, as previously demonstrated by other research studies (Noland, 2003).

Regarding the variable average age, for our case, a positive relationship has been found with the road traffic fatalities. This finding is in line with the previous literature that shows that even though the youngest drivers present a more reckless driving behaviour, elderly drivers may have deteriorated physical and cognitive capabilities that can lead to worse road traffic safety variable figures (Li et al., 2003).

In addition, regarding the relationship between the capital city and total regional population ratio and the road safety variables, a positive relationship is also found with traffic mortality and a negative relationship with traffic accidents. This result indicates that NUTS-3 regions with a larger ratio of the population concentrated in the capital city record fewer traffic accidents because they show agglomeration gains and, therefore, fewer people need to travel to access essential services and leisure (Sánchez-González et al., 2018). However, there is a higher mortality rate precisely because these are more complicated traffic environments, and although there are fewer accidents with lower exposure, they are more severe, and roadside medical assistance is slower (Gedeborg et al., 2010). An additional plausible explanation is that higher agglomeration leads to more favourable road conditions and an increase in leisure trips that eventually impact mortality.

The motorization rate coefficient is negative for traffic fatalities, which shows a positive impact on road traffic fatalities in the sense that higher motorization rates lead to fewer traffic fatalities, which is in line with the findings of the previous scientific literature (Castillo-Manzano et al., 2015; Noble et al., 2015). A higher motorization rate does not necessarily imply greater mobility and exposure, especially in developed countries, where positive externalities may appear linked to this variable, including the more frequent renewal of vehicle stock that is related to fewer traffic fatalities (Aparicio-Izquierdo et al., 2013).

Regarding infrastructure, a negative relationship has been found between the highways ratio and the deaths caused by road traffic accidents. A higher density of high-capacity roads has previously been shown to be a proxy of road traffic safety improvements (Sánchez-González et al., 2018).

The number of tourists shows an opposite effect on fatalities and accidents. Whilst a higher number of tourists in the NUTS-3 region correlates with a higher number of accidents, the severity of these accidents and the fatality rate are lower. The higher presence of tourists can lead to greater traffic congestion, which implies a higher number of accidents (Castillo-Manzano et al., 2020) at a lower speed and, therefore, a lower fatality rate.

Finally, the annual precipitation coefficient is positive for traffic fatalities. This is empirical evidence that rainy weather and poor meteorological conditions lead to an increase in the severity of accidents and the consequent deterioration of traffic safety variables (Stevens et al., 2019).

It must also be highlighted that the time trend (modelled with the variable period) is negative for many of the models included in Table 5 and Table A3 in Appendix A in the supplemental data online. As the trend has a statistically significative relationship with the variables, it has been retained in the majority of the models.

CONCLUSIONS

In recent decades, there has been a trend in many high-income countries for central governance in public policy to be progressively replaced by more local and regional decision-making. In this line, responsibilities for road safety policy are shared between national (central or state), regional, provincial and/or local (municipal) governments and authorities in some countries such as Spain, where traffic law enforcement services are decentralized in a set of regions.

The originality of this paper lies in the fact that it is the first to examine and find empirical evidence for the case of traffic police departments and also provide support for the theory that, in certain cases, the centralization of some specific public policies might be more beneficial to society.

Regarding this, our results demonstrate that the regions in Spain where traffic law enforcement comes under national policing present lower road traffic accident and mortality figures, which shows that regional traffic police governance might be less effective than central traffic police management in this particular case. This strong correlation has been found through the use of panel data for 50 NUTS-3 regions, a 16-year period and with a set of control variables being considered to assess other factors.

Our findings could also be extended to explain centralized management in other road safety areas such as publicity campaigns, traffic signage and legislation. However, this is in contrast with other public services in Spain (e.g., street lighting, street cleaning, and drinking water supply) where decentralization is shown to improve the effectiveness and efficiency of local administrations (Balaguer-Coll et al., 2010).

The key points that might explain the difference in the performance of the national and regional traffic police forces are in line with those previously empirically demonstrated for other public services, namely, a centralized approach (1) enables access to higher skilled resources, (2) enables enhanced monitoring and control systems, and (3) is inherently simpler to coordinate compared with a decentralized approach (Segal, 1997). For our specific case, and according to our novel results, the *'top-down' coordinated management* of traffic law enforcement may be desirable in Spain, because although the devolution of competencies for supervision and enforcement of this legislation has been recognized for certain regions for over two decades, the same traffic regulations are applied equally in all territories. It should also be considered that, unlike other public services such as healthcare and education, which only the respective residents of each of the regions can benefit from, everyone who uses the Spanish state highway network can do so without any constraints or distinctions regarding their points of origin, which generates what is known as 'network economies'. Moreover, centralized management in Spain would enable resources to be better allocated to the regions, especially in the case of instruments with a high economic cost, such as road traffic surveillance helicopters. This advantage is especially important during the tourist season, when centralized management enables the transfer of police and material resources, such as mobile speed cameras, from the centre of the Spanish mainland to the coasts and archipelagos in regions that share the same traffic policy.

Therefore, taking into account our findings, the provision of public services such as those analysed in the current paper (i.e., traffic police enforcement), where economies of scale and network effects are involved, can be centralized if gains are made from the process in terms of better road safety figures.

In this sense, it might be useful to extrapolate this idea to other territories and/or countries with traditional traffic police decentralization (such as, e.g., the UK and Germany), and to issues where economies of scale and network effects are found, perhaps by applying mixed performance that combines centralized and decentralized elements to generate some possible savings derived from coordinated central road safety management. The case of the Netherlands is worth highlighting in this regard. Although Dutch road safety policy was decentralized and the division of responsibilities was clearly defined by the Traffic and Transport Planning Act of 2005, after decades of decentralization of road safety activities, the recent National Traffic and Transport Plan for 2001–2020 recognized the key role of central government to conduct a coherent road safety policy, according to the motto: 'local where possible, central where necessary' because 'if progress is still insufficient, or if a situation is having a negative influence on road safety, stronger central control may become necessary' (Dutch Ministry of Transport, Public Works and Water Management, 2009).

All the above may indicate that there is no single valid approach to decentralization and detailed analyses should be carried out on a case-by-case basis to determine the best decentralization level for each group of public policies depending on specific country/region characteristics (Aslim & Neyapti, 2017).

In summary, policymakers should consider the results of this paper to define future decentralization/recentralization strategies in the debate on the full decentralization of traffic police in the Spanish NUTS-3 region of Navarre (Calvo, 2018). Also, greater collaboration and shared use of some specific resources would be desirable between the central traffic police operating in 43 of the 50 Spanish NUTS-3 regions and the regional police forces that operate in the Catalonian, Navarre and Basque Country NUTS-3 regions.

An effort should be made to promote these same strategies based on greater collaboration and more shared resources among the different national traffic police departments and via initiatives such as TISPOL (the European Traffic Police Network) on the supranational level.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study were derived from the following resources available in the public domain: (1) Accidents on interurban roads; Fatalities on interurban roads; and Driver census (exposure variable), all from the Spanish General Traffic Directorate Yearbook. (2) Decentralization, from the Spanish Ministry of Internal Affairs. (3) Unemployment rate; Average age; Ratio of population in capital city; Motorization rate; Tourists; and Per capita GDP, all from the Spanish National Statistics Institute (INE). (4) Highways ratio, from the Spanish Ministry of Transport, Mobility, and Urban Agenda. (5) Precipitation, from the Spanish State Weather Agency). (6) Population density, from Eurostat. (7) Hospital density, from the National Hospitals Catalog – Spanish Ministry of Health, Consumer Affairs, and Social Welfare (see Table 3).

DISCLOSURE STATEMENT

No potential conflict of interest was reported by the authors.

FUNDING

This work was supported by the Andalusian Government of Spain (Junta de Andalucía. Consejería de Economía y Conocimiento) under Grant to I+D+i research projects (European Regional Development Funds) 2014–2020, number US-15508.

NOTES

1. Endogenous variables are modelled using a Poisson distribution with driver census as the exposure variable.
2. 'Paso del Estrecho' refers to the operation managed jointly by Spain and Morocco whereby more than 3 million immigrants travel each summer from Europe to their countries of origin in North Africa, requiring them to transit through Spain by vehicle.

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