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Research Article

Beyond the Economy: Metropolitan Mobility and the Relevance of the Peak-Car Concept

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Abstract: Daily mobility in urban areas is crucial for the successful implementation of an energy transition aligned with decarbonisation and sustainability objectives. Using the case of the Valencia metropolitan area, this study examines empirical evidence to determine whether there is a decline in private car use and the conditioning factors influencing this trend. The primary data sources include car ownership and driver census data from the General Directorate of Transport (Spanish government), monthly average daily traffic data from Valencia City Council, and passenger statistics from various transport companies in the region. Urban mobility data are analysed in relation to socio-economic and territorial factors. Within the conceptual framework of the peak-car hypothesis, we present evidence suggesting a decoupling between economic trends and the evolution of motorisation and car use. This finding highlights the necessity of exploring additional influencing factors, including territorial, political, cultural, and socio-demographic dynamics. Notably, the policy shift towards more sustainable mobility, initiated a decade ago, appears to have been significantly effective.

Keywords: car ownership; car use decoupling; urban form and design; urban mobility policies; Valencia Metropolitan Area (Spain)

Highlights:

- The peak-car concept remains a useful tool for analysing mobility transitions.
- A decoupling process between car use and the economic cycle is underway.
- Public policies regulating the use of public space are the most effective, even in scenarios with limited financial resources.
- The recent decline in urban residential density does not appear to be a significant factor in reducing car use.
- The dramatic increase in public transport usage following the COVID-19 pandemic is not accompanied by the necessary public investment to expand and improve its quality.

1. Introduction

There is broad consensus that the necessary transition to a low-carbon economy requires changes in freight and passenger transport patterns and modes. According to the latest report from the Intergovernmental Panel on Climate Change (IPCC, 2023, p. 44), the transport sector is currently responsible for an estimated 15% of total greenhouse gas emissions. This figure has proven resistant to decline, as improvements in fossil fuel efficiency are outweighed by the overall increase in emissions driven by population and income growth, expanding urbanisation, and unsustainable urban development. However, significant reductions—estimated at 67% of emissions by 2050 compared to baseline levels (IPCC, 2023, p.103)—are achievable through a combination of low-cost mitigation measures (such as public transport and cycling) and policies that can be readily implemented at the urban scale (such as land use planning and urban development), offering a high potential for synergy. Much of the focus is placed on the need to alter mobility patterns by reducing travel demand (in terms of both frequency and distance), promoting active mobility (such as walking and cycling), and limiting private car use. These changes are closely linked to the transformation of urban form towards denser, more diverse, and well-designed neighbourhoods (Cervero and Kockelman, 1997).

However, the future role of the private car in urban mobility extends beyond its impact on climate change. To assess this, it is necessary to consider all the externalities of car use—both local and global—as well as shifts in public attitudes, policy directions, and, more broadly, the evolving urban model. Over recent years, a significant body of theoretical and empirical research has emerged around the peak-car concept, which analyses changes in mobility patterns—particularly the rise and decline of the private car as the dominant mode of transport—from a multidimensional, long-term perspective (Metz, 2013).

Within this framework, the primary objective of this article is to assess the extent to which the peak-car concept is applicable to Spain's third-largest urban area, the Valencia Metropolitan Area (VMA). The VMA has recently undergone significant urban expansion, and its growth and mobility trends may provide valuable insights for other middle-income countries. In particular, this study aims to examine the dynamics surrounding the tipping point of peak-car, identifying key factors that may act as triggers or contributors to a new mobility model. Given that the VMA is a

middle-income city that has recently experienced rapid growth—albeit with notable deficiencies in public transport provision—its case study can shed light on the mobility processes occurring in second-tier metropolitan areas, aligning with the concept of “ordinary cities” as proposed by Robinson (2006).

To achieve this, the paper first provides a brief review of the peak-car phenomenon and the various explanations that have been proposed. This is followed by an in-depth analysis of the VMA, identifying the scope and timing of peak-car within the region and examining the factors that may explain or accompany this shift. Finally, conclusions are drawn in relation to the theoretical framework outlined earlier.

2. Literature Review

Since the early 21st century, a trend towards the stabilisation of per capita levels of private motorisation and car use has been observed in some developed countries, albeit with varying timelines and intensities (Schipper et al., 1993; Millard-Ball & Schipper, 2010; ITF, 2013; Focas & Christides, 2017). In certain cases, there has even been a decline following a peak reached around 2005, a phenomenon primarily observed in advanced Western European countries such as the UK, the Netherlands, and Sweden (Focas & Christides, 2017). The emergence of a new, dematerialised mobility paradigm is reshaping the dominance of the car in social and spatial relations (Sheller & Urry, 2006). However, in light of recent developments, the concept of peak-car remains elusive, as it is highly dependent on conjunctural dynamics and specific territorial factors, making it difficult to form a clear and generalised understanding of the processes at play. Recent developments over the past decade have raised doubts about both the imminence and scale of the peak-car phenomenon. In the EU-27 as a whole, private motorisation has continued to grow, although a certain slowdown has been evident since 2019, particularly in countries with already high motorisation rates, such as France and Germany. However, overall car ownership continues to rise, especially in Southern and Eastern European countries where initial levels were lower, such as Portugal, Poland, and Romania. A decline in private car ownership has been observed only in a few wealthier nations (e.g., the Netherlands, Switzerland, the Scandinavian countries) and in Spain, which diverges from the broader Southern European pattern.

This context supports Goodwin's (2012) assertion that analyses of peak-car should move beyond the national scale, as national-level assessments introduce significant biases and distortions. Instead, urban case studies should be prioritised, considering the specific characteristics of each territory, the orientation of public policies, and the role of various intervening factors. Given Spain's recent and notable shift, a more detailed analysis of its case may provide useful insights into the current validity of conventional explanations for peak-car and enhance understanding of the broader phenomenon.

Much of the discourse surrounding peak-car revolves around two fundamental questions:

- a) Whether the phenomenon is purely conjunctural or represents a permanent, long-term shift.
- b) The nature of the underlying factors—whether economic variables alone are sufficient in explaining the trend or whether broader social, political, or territorial factors must also be considered.

These two issues are closely interconnected. Arguments for a conjunctural and cyclical interpretation often centre on economic variables such as the income of a population and the costs of owning and using a car. On the other hand, the notion of a long-term, structural shift is often linked to profound transformations in social, political, and territorial dynamics.

In this context, Goodwin (2011, 2012) categorises explanations for the nature and determinants of peak-car into three overarching hypotheses, each centred on a distinct concept:

- a) *Interrupted growth*: This hypothesis attributes peak-car to economic factors, including slow household income growth, persistent unemployment levels (particularly among young people), and rising costs associated with the purchase and use of a vehicle—especially fuel prices (Bastian et al., 2016). Accordingly, once economic growth resumes, motorisation levels would be expected to recover and potentially increase.
- b) *Saturation of mobility demand*: This perspective is based on the 'travel time budget' concept proposed by Zahavi (1974), which posits that the time people are willing to spend commuting is fixed and limited. Once a certain threshold is reached, further income growth does not necessarily translate into increased mobility demand (Metz, 2010). As income elasticity declines, motorisation levels may gradually decouple from economic conditions and stabilise at a high level.
- c) *Multidimensional civilisational change*: An increasing number of scholars argue that understanding peak-car requires consideration of the broader changes taking place in social, cultural, and political spheres (Metz, 2013). For example, peak-car could be linked to demographic variables such as the ageing population (Metz, 2012; Kuhnimhof et al., 2013), changes in the life cycle (Paul & Blumenberg, 2023) or a growing immigrant population (Goodwin, 2012). Additionally, shifts in social attitudes—such as the diminishing significance of obtaining a driving licence, particularly among young men (Delbosc & Currie, 2013; Hjorthol, 2016)—and increasing awareness of the environmental problems associated with car use (Lee-Gossein, 2017), are influencing mobility patterns. Furthermore, mobile devices and the hyper-connectivity they enable are reshaping behaviours in several aspects of social life, including e-commerce, teleworking, and leisure, thereby reducing the demand for mobility (Olde et al., 2021). From a policy perspective (both local and regional), new approaches to land use and urban planning that promote active mobility (e.g., cycling and walking) and the provision of public transport, also help provide alternatives to car use, especially in urban areas with high residential densities, mixed land uses and pedestrian- and cyclist-friendly infrastructure (Cervero & Kockelman, 1997). Collectively, these processes are expected to contribute to a reduction in the demand for travel and motorisation, giving rise to a new mobility paradigm, characterised by shorter travel distances, increased pedestrianisation, a renewed emphasis on proximity and walkability, and the growth of active mobility (Bartzokas-Tsiompras, 2022; Bartzokas-Tsiompras & Bakogiannis, 2023; Moreno, 2023).

Of course, these three explanations are not mutually exclusive and may interact with each other, leading to varying territorial trends and developments. Therefore, conducting specific case studies—preferably at the metropolitan level—can provide valuable insights into the variables and driving factors shaping car use. Such analyses can help determine whether factors beyond economic development play a significant role in explaining car ownership and usage patterns. While there is a degree of income elasticity of car use—both at individual and societal levels—that indicates a certain dependence on the economic cycles (Litman, 2017), other long-term trends may also be at play. If these trends contribute to a decline in car use, they could serve as critical levers for public policies aimed at promoting urban sustainability.

3. Materials and Methods

3.1 Analysis and data sources

This study used the metropolitan area of Valencia as a case study to assess whether there has been progress towards a more sustainable mobility pattern, characterised by reduced dependence on private cars. If such a transition is occurring, the study aims to identify its underlying factors and determinants. Within the conceptual framework of peak-car, the initial step involved examining the co-evolution between car ownership and use and key economic variables such as employment and gross domestic product. This potential co-evolution was first assessed graphically to identify sub-periods exhibiting similar behaviour. Where necessary, moving averages and time-series smoothing techniques were applied to monthly or quarterly data to eliminate seasonal variations. In each identified sub-period, Pearson correlation tests were then conducted to determine both the strength and direction of relationships between variables—either direct (R with a positive sign) or inverse (R with a negative sign). A negative Pearson correlation coefficient in the context of employment and economic growth could indicate a decoupling process between private car use and the business cycle. This methodology aligns with previous research that has sought to detect the emergence of the peak-car phenomenon (Millard-Ball & Schipper, 2011; Goodwin, 2011, 2012; Focas & Christidis, 2017). However, in this study, our analysis was strengthened by employing statistical correlation techniques. Moreover, whenever possible, the different areas within the metropolitan region were examined separately, acknowledging their distinct territorial characteristics and mobility patterns.

Table 1. Variables and data sources. Source: Authors' own elaboration.

Variable	Description	Period	Frequency	Data source (link)
Car ownership	Private cars/1000 inhabitants	2015-2023	Yearly	General Directorate of Traffic
Average daily traffic	Number of vehicles passing through automated traffic-counters (roads)	2008-2023	Monthly	Mobility maps. Valencia City Council
Employment	Number of people employed	2008-2023	Quarterly	Labour force survey (INE)
Gross Domestic Product	Euros	2008-2023	Yearly	Spanish regional accounts (INE)
Travellers in public transport	Number of trips started on a public transport mode	2016-2023	Yearly	Statistical yearbook. Valencia City Council
Use of bicycles	Number of bicycles passing daily through automated traffic-counters (bike lanes)	2016-2023	Monthly	Mobility maps. Valencia City Council
Urban density	Residents per hectare of urbanised space	1990-2023	Yearly	General Directorate of Cadastre Population statistics (INE)
Ageing	Percentage of population aged 65 and over	2015-2023	Yearly	Population statistics (INE)
Immigrant population	Percentage of foreign-born residents	2015-2023	Yearly	Population statistics (INE)
Driving licences	Percentage of residents aged 18 and over holding a driving licence	2015-2023	Yearly	General Directorate of Traffic Population statistics (INE)

Once the degree and direction of co-evolution between economic variables and private car use had been established, the study examined the role of additional factors in shaping mobility patterns and potential car abandonment. In line with existing literature, three broad categories were considered: territorial factors related to urban form and density, transport accessibility relating to the availability and use of alternative modes (cycling, public transport), and socio-demographic factors relating to an ageing population, immigration, and driving licence acquisition (See Table 1).

To calculate residential densities, built-up areas were extracted from cadastre records, which provided annual data on the growth of urbanised areas over an extended period of time—an advantage not offered by other land use databases. The surface area obtained included only buildings, excluding roads, parks, and other public spaces, meaning that the estimates were somewhat underestimated. However, using this data source enabled the identification of key land use trends over time. Given that the current urban form is largely dependent on past development processes, this methodological approach made it possible to observe the process from 1990 onwards, distinguishing between four key real estate cycles in Spain: a) 1990-1997, b) 1997-2008, c) 2008-2015 and d) 2015-2023.

Data on socio-demographic variables and transport use by mode have been collected since 2015-2016, a period that coincided with a turning point in economic dynamics. This shift marked the beginning of a new phase of growth, raising the possibility of a decoupling between the economic cycle and car use. Additionally, 2015 marked the start of a new political cycle, with a left-ecological coalition taking office at both the local and regional levels. In this context, the study also examines the role of public policies in enhancing the sustainability of metropolitan mobility, as well as the challenges that must be addressed to optimise their impact.

3.2 The Valencia Metropolitan Area (VMA) as case study

With the exception of Barcelona, Spain does not have officially designated metropolitan areas (Tomás, 2023). Consequently, for this case study, we adopt the functional urban area proposed by the EU-OECD (EUROSTAT, 2017). Additionally, to account for variations in behaviour, we differentiate three areas within the VMA: a) the central city, b) an inner conurbation comprising municipalities adjacent to the central city, and c) an outer peripheral area, which has commuting links with the rest of the metropolitan area but lacks physical continuity (see Figure 1).

The VMA is the third-largest metropolitan area in Spain, following Madrid and Barcelona, with a population of just over two million. Feria (2013) classifies it as part of a second-tier metropolitan region within the Spanish urban system, alongside Seville and Bilbao. However, its recent demographic dynamism, driven by intense immigration (see Table 2), has made its growth trajectory more comparable to that of Madrid and Barcelona, the leading urban centres in Spain. Between 2015 and 2023, the VMA's population grew by 5%, reinforcing its role as a key urban hub. As a consolidated metropolitan area, the VMA has reached a high level of maturity and a complex internal structure. Notably, only 39.7% of its population resides in the central city, while the remaining 60.3% is distributed across the wider metropolitan region. Although intra-metropolitan mobility and flows remain predominantly radial, defining a markedly monocentric territorial structure, the emergence of new sub-centres suggests a gradual transition towards a more complex and polycentric urban form. While all parts of the VMA have experienced population growth, outer areas have seen the highest increase (8.9%), followed by the inner conurbation (6.1%), whereas the central city has expanded at a more modest rate (2.7%).

Table 2. Population dynamics in the Valencia Metropolitan Area. Data source: National Statistical Institute (2024a).

	2015		2023		% Growth 2015-2023
	Population	%	Population	%	
Central city	786,189	40.7	807,693	39.7	2.7
Inner conurbation	597,719	31.0	634,356	31.2	6.1
Outer functional area	545,846	28.3	594,266	29.2	8.9
Valencia Metropolitan Area	1,929,754	100.0	2,036,315	100.0	5.5

The metropolitan evolution of Valencia has unfolded over a period of more than 150 years, shaped by both railway expansion and the rise of automobile use (see Figure 1). Transport infrastructure has played a defining role in the transformation of the urban structure and the distribution of the population. According to Zornoza (2022), between 1900 and 1970, municipalities without railway access experienced slow population growth or even decline, whereas those served by rail grew rapidly. On the other hand, during the period between 1981 and 2021, cities without railway connections experienced the highest growth rates, signifying a shift towards the car as the most important means of transport. The railway system historically concentrated development, creating high-density nodes around its stations. By contrast, the proliferation of private car ownership allowed urbanisation to extend across the entire metropolitan area, resulting in low-density settlements. Despite ongoing changes, the VMA remains predominantly monocentric, a characteristic still evident in both its road network and public transport infrastructure, which includes trains, metro, trams, and buses.

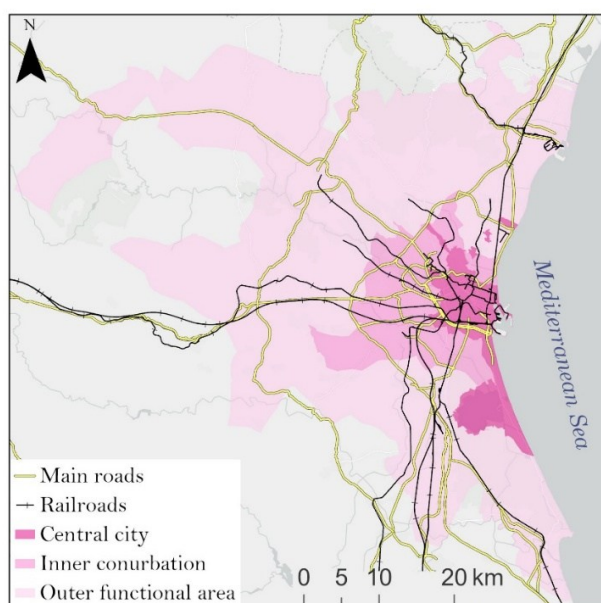


Figure 1. Main roads, railways and spaces in the VMA. Data source: Valencian Spatial Data Infrastructure.

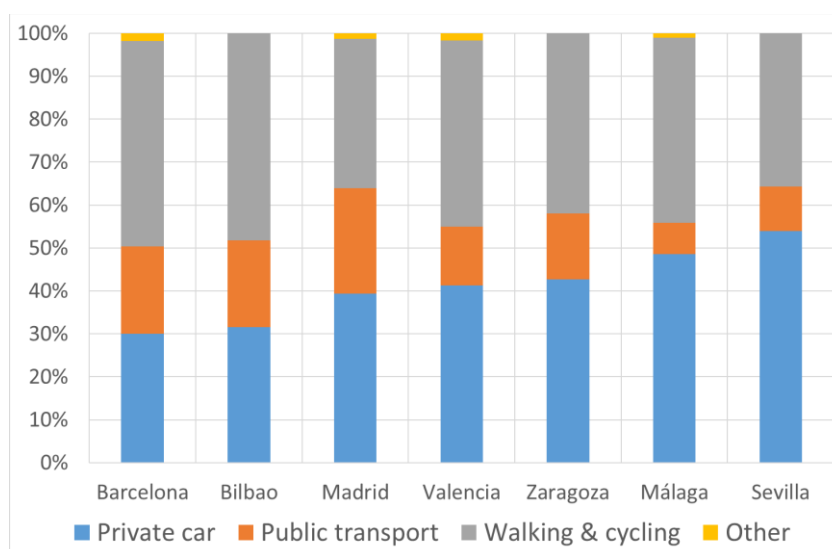


Figure 2. Modal split in the seven Spanish metropolitan areas with populations exceeding 1 million. Data source: Metropolitan Mobility Observatory (2023).

As illustrated in Figure 2, in the VMA, cars account for 41% of total trips, while active mobility (walking and cycling) constitutes 43%, and public transport represents just 14%. From a sustainability perspective, this mobility model indicates an overreliance on private cars, particularly when compared to Barcelona and Bilbao. This disparity may be attributed to the poor performance of public transport. However, the high share of active mobility suggests a more compact and pedestrian-friendly urban structure, particularly in comparison to Madrid and Seville (Albertos, 2014; Maestro & Albertos, 2017). The sustainability of mobility patterns improves considerably when focusing solely on the central city of Valencia, where car use drops to 22%, active mobility rises to 55%, and public transport usage increases to 22%. However, the situation is markedly different for commuting between the city centre and the suburbs, where car dependency reaches 69%, public transport usage rises slightly to 24%, and active mobility remains minimal at just 5%. These figures highlight that, in the case of the VMA, the key challenge in decarbonising mobility and reducing car dependency lies at the metropolitan scale, where improving public transport accessibility and reliability will be essential to fostering a more sustainable transport system.

4. Results

4.1 Co-evolution of car ownership, usage, and the economic cycle (2008-2023)

Recent evidence on peak-car in Spain's main metropolitan areas presents an ambivalent picture (Table 3). While motorisation levels generally increased during the post-2015 economic recovery phase, there has been some slowdown since 2019, and, in some cases, even a recent decline. The situation and trajectory of each metropolitan area depend on a unique combination of factors, including urban form and structure, size, transport infrastructure and facilities, wealth, socio-demographic characteristics, social attitudes, and public policies (Escolano et al., 2024). The metropolitan areas of Madrid and Barcelona, despite their similar size, exhibit stark contrasts (Gutiérrez, 2005, 2007; Marquet & Miralles, 2017). Madrid has a high and increasing motorisation rate, approaching 600 cars per 1,000 inhabitants, whereas Barcelona has a low and declining motorisation rate, having fallen below 400 cars per 1,000 inhabitants since 2019. In 2015, the difference between the two metropolitan areas was around 100 cars per 1,000 inhabitants; by 2023, this gap had widened to nearly 200 cars per 1,000 inhabitants.

Table 3. Car ownership Spanish metropolitan areas with populations over 1 million (2015-2023). Data source: General Directorate of Traffic (2024).

Metropolitan area	Car ownership (cars per 1,000 inhabitants)				Δ Car ownership		
	2015	2019	2021	2023	2015-19	2019-21	2021-23
Madrid	512	568	576	589	+56	+8	+13
Barcelona	409	418	409	397	+9	-9	-12
Valencia	459	485	488	478	+26	+3	-10
Sevilla	453	485	492	493	+32	+7	-9
Bilbao	464	501	502	496	+37	+1	-6
Zaragoza	433	454	455	455	+21	+1	=
Málaga	396	417	422	421	+21	+5	-1

Within this national context, the VMA occupies an intermediate position. Since 2019, motorisation levels have stabilised, with a downward trend only emerging from 2021 onwards. To better understand these dynamics, it is essential to analyse trends across different zones within the metropolitan area. (Table 4). Car ownership is notably lower in the central municipality of Valencia and increases towards the periphery. This spatial variation has also shaped recent trends: in the central city, motorisation has remained almost stagnant and has not recovered to 2015 levels, whereas in the outer metropolitan area, it has seen sustained and more intense growth. In 2015, the total metropolitan area was relatively homogeneous in terms of car ownership (a 34-point difference between the central city [446 cars per 1,000 inhabitants] and the outer metropolitan area [480 cars per 1,000 inhabitants]). However, by 2023, this gap had more than doubled to 76 points.

Table 4. Car ownership in the VMA (2015-2023). Data source: Data source: General Directorate of Traffic (2024).

	Car ownership (cars per 1,000 inhabitants)				Δ Car ownership		
	2015	2019	2021	2023	2015-19	2019-21	2021-23
Central city	446	455	459	443	+9	+4	-16
Inner conurbation	458	490	492	483	+32	+2	-9
Outer functional area	480	521	524	519	+41	+3	-5
Valencia Metropolitan Area	459	485	488	478	+26	+3	-10

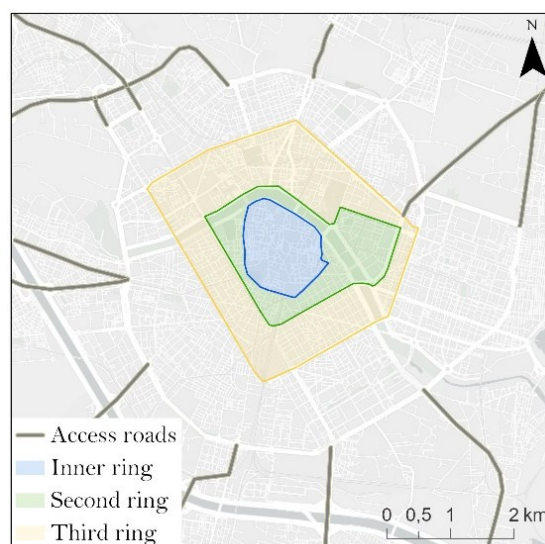


Figure 3. Main access roads and ring roads in Valencia. Data source: Valencian Spatial Data Infrastructure.

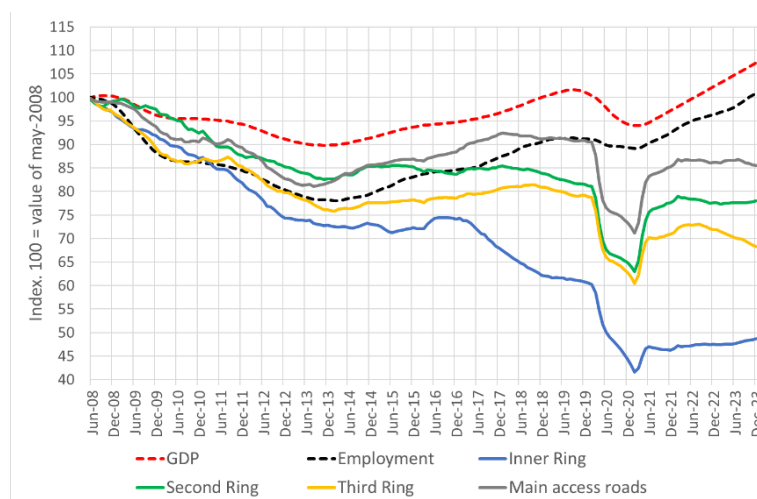


Figure 4. Average daily traffic in the main access and ring roads in Valencia (2008-2023). Moving average of the previous 12 months. Data Source: Valencia City Council (2024a) and National Statistical Institute (2024b, 2024c)

The peak-car phenomenon can also be analysed in terms of car usage, a variable that is more sensitive to cyclical fluctuations but is critical for the transition towards sustainable mobility models. We can observe car use patterns by analysing traffic flow data. Here, the territorial scale of travel is particularly relevant. Therefore, Figures 3 and 4 distinguish between: 1) traffic within the central city (measured along Valencia's three internal ring roads) and 2) traffic entering and exiting the central city via main access roads. The first measure assesses the impact of car mobility within Valencia, while the second reflects metropolitan-scale commuting patterns. To illustrate the potential impact of economic trends on these patterns, we also examine the evolution of GDP and employment levels.

Between 2008 and 2013, traffic volumes in Valencia declined significantly, mirroring the economic downturn during the global financial crisis (Figure 4). This decline was observed across all ring roads. However, from mid-2013 onwards, the parallel correlation between traffic volume and economic growth weakened. During the economic recovery period (2013–2017), the volume of traffic initially stabilised before starting to decline, especially in central areas (notably, the inner ring near the old city walls). However, this decline also extended to the second and third ring roads. Notably, the reduction in traffic was not only confined to the central city: traffic on access roads to Valencia, indicative of metropolitan-scale commuting, exhibited a similar downward trajectory. Between 2008 and 2017, metropolitan traffic closely followed the economic cycle of crisis and recovery. Recovery begins in 2013 and reaches its peak in late 2017, though it never managed to return to pre-crisis 2008 levels. However, from 2018 onwards, metropolitan traffic entered a phase of significant decoupling from the broader economic expansion. The disruption caused by the COVID-19 pandemic to mobility patterns did not fundamentally alter these trends.

Table 5. Pearson correlation coefficients between economic variables and traffic on selected roads. VMA (2008–2023). Data source: Valencia City Council (2024a) and National Statistical Institute (2024b, 2024c).

Traffic roads	2008-2013		2013-2018		2018-2023	
	Employment	Gross Domestic Product	Employment	Gross Domestic Product	Employment	Gross Domestic Product
Access roads	0.964	0.995	0.955	0.971	-0.933	-0.595
First Ring	0.943	0.976	-0.535	-0.540	-0.897	-0.528
Second Ring	0.905	0.941	0.501	0.543	-0.915	-0.639
Third Ring	0.989	0.988	0.963	0.969	-0.977	-0.717

All coefficients are significant with a *p*-value of less than 0.005 (one tailed).

More formally, the co-evolution of economic and transport variables can be assessed by calculating correlation coefficients for the three distinct periods (Table 5): 1) 2008–2013, 2) 2013–2018, and 3) 2018–2023. Using both employment and GDP as economic indicators, the resulting correlation coefficients are notably high and statistically significant for both for metropolitan traffic—measured on radial access roads—and traffic within the central city. The key findings are as follows:

- A strong positive correlation was observed during the economic crisis (2008–2013), when declining employment and economic activity led to a sharp reduction in mobility.
- From 2013 onwards, as the economy began to recover, this correlation weakened. Although traffic on access roads and the third ring road continued to increase in line with economic variables, a clear decoupling emerged in the inner rings. Traffic on the first ring road declined, resulting in a negative correlation, while the second ring road showed early signs of a similar trend. This suggests that central urban areas were at the forefront of a shift towards new mobility patterns.
- In the most recent period (2018–2023), decoupling has become widespread, with consistent declines in all forms of transport across all territorial scales. Correlation coefficients are now negative in all cases. It is also interesting to note that this decline in transport activity preceded the decline in car ownership, indicating that behavioural changes occur before individuals decide not to have a car or to replace it.

4.2 Urban density: has anything changed?

The overall urban density of the VMA (see Table 6) has decreased drastically from 1990 to the present. This trend aligns with the broader urban development patterns observed since the advent of motorised transport (Dupuy, 1995; Monclús, 1998; Bretagnolle, 2009). In Europe, this process began in the 1970s (Monclús, 1996), although each city has followed a distinct trajectory. In the VMA between 1990 and 2008, urban sprawl was particularly pronounced: while the population grew by 22%, the built-up area expanded by 49%, leading to a 20% decrease in density—from 135 to 110 inhabitants per hectare. This phenomenon was especially pronounced in suburban areas, where the built-up area increased by 55% (3,790 hectares), but the population grew by just 157,000, resulting in a low density of 41 inhabitants per hectare. This low-density metropolitan expansion coincided with the housing and credit bubble, which collapsed in 2008, occurring in a context of weak territorial planning and metropolitan governance. This lack of regulation led to inefficient public resource allocation and contributed to the creation of a car-dependent urban landscape (Burriel, 2008; Romero, 2010; Romero et al., 2018). During the peak of the real estate boom (1997–2008), the built-up area expanded at an unprecedented rate of 381 hectares per year, with 78% of this growth occurring on the periphery of the metropolitan area, further exacerbating urban sprawl. Following the economic crisis (2008–2015), densities continued to fall as the built-up area increased while the population experienced a slight decline. However, from 2015 onwards, a shift in this trend became evident, with urban density beginning to increase modestly from 2021, largely driven by overall population growth, including in the central city.

Table 6. Urban density, population and built-up area (1990–2023). Data source: National Statistical Institute (2024a) and General Directorate of Cadastre (2024).

	Urban density (inhabitants/Ha.)						
	1990	1997	2008	2015	2019	2021	2023
Central city	457.0	408.7	378.8	353.0	354.2	349.9	356.4
Inner conurbation	143.7	133.4	126.0	122.0	122.6	123.7	126.2
Outer functional area	54.0	51.0	49.7	48.7	49.0	49.5	51.1
Valencia Metropolitan Area	134.9	121.8	110.3	105.2	105.4	105.3	107.6

	Population (inhabitants)						
	1990	1997	2008	2015	2019	2021	2023
Central city	752,909	739,412	814,208	786,189	794,288	789,744	807,693
Inner conurbation	457,738	485,085	591,041	597,719	608,959	618,286	634,356
Outer functional area	374,619	403,971	532,384	545,846	558,310	572,291	594,266
Valencia Metropolitan Area	1,585,266	1,628,468	1,937,633	1,929,754	1,961,557	1,980,321	2,036,315

	Built up area (Ha.)						
	1990	1997	2008	2015	2019	2021	2023
Central city	1,647	1,809	2,150	2,227	2,242	2,257	2,266
Inner conurbation	3,185	3,637	4,692	4,899	4,967	4,997	5,025
Outer functional area	6,932	7,926	10,722	11,210	11,397	11,552	11,631
Valencia Metropolitan Area	11,764	13,372	17,564	18,336	18,606	18,806	18,922

Urban form and density are strongly related to mobility patterns. Miralles (2002) describes this relationship as an “imperfect binomial” because of the inefficiency of treating them separately in urban planning. In the VMA, population density decreases with distance from the metropolitan centre, correlating with a higher reliance on private cars in peripheral areas. Over the long term (1990–2023), the number of residents in these low-density suburbs has grown by 219,647, increasing from 23.8% to 29.2% of the total VMA population. Many former Valencia residents have relocated to the outskirts, converting second homes into primary residences, while new low-density neighbourhoods continue to emerge. These developments are heavily car-dependent, posing a real challenge to the sustainability of metropolitan mobility. Furthermore, although the recent demographic recovery (2021–2023) of the denser central city is a positive trend in terms of sustainability, it remains small and short-term. In conclusion, while recent trends in urban density suggest a gradual shift towards more sustainable mobility, the existing territorial metropolitan model—shaped largely during the years of the property boom (1990–2008)—continues to reinforce the dominance of private car use.

4.3 Mobility in alternative transport modes

The decline in car use (Figure 5) is particularly pronounced within the city of Valencia, where it has decreased by 14% between 2016 and 2023, compared to just 2% in the metropolitan area. This suggests that the central city is at the forefront of the transition to sustainable mobility, whereas the metropolitan peripheries are slower to adopt this new behaviour. A key factor in this disparity is the varying accessibility of alternative modes of transport. The recent expansion and interconnection of a high-quality cycling paths in Valencia have led to a significant surge in bicycle usage, which has increased by 80% since 2016. Similarly, public transport usage has experienced a strong resurgence following the abrupt decline caused by the COVID-19 pandemic. Between 2016 and 2023, public transport journeys in Valencia increased by 15%, contrasting with the concurrent 14% decline in traffic.

At the metropolitan level, where car dependency remains high, the future of mobility is particularly critical (Figure 6). Notably, even in this car-oriented environment, motorisation rates have recently begun to decline, and car usage for journeys to and from Valencia has slightly decreased. While these trends are undoubtedly promising, the most significant change has been in the number of passengers using public transport for trips within the city. Between 2016 and 2023, the number of passengers using public transport increased by 43%, more than doubling from the lows recorded during the pandemic. The demand for mobility at metropolitan level is growing rapidly, and this increase is primarily benefiting public transport rather than private car usage (Table 7). Consequently, the modal distribution of motorised trips between Valencia and its metropolitan area is undergoing a substantial shift. Following the mobility crisis of 2020, overall travel has increased, surpassing 2019 levels by 2023. Notably, while public transport accounted for only 19.3% of these trips in 2019, its share reached a record high of 24.4% in 2023.

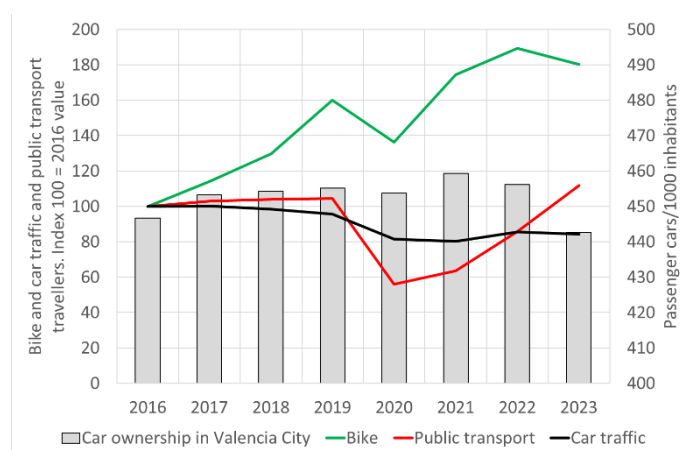


Figure 5. Mobility trends inside the city of Valencia. Data source: Valencia City Council (2024a, 2024b) and General Directorate of Traffic (2024).

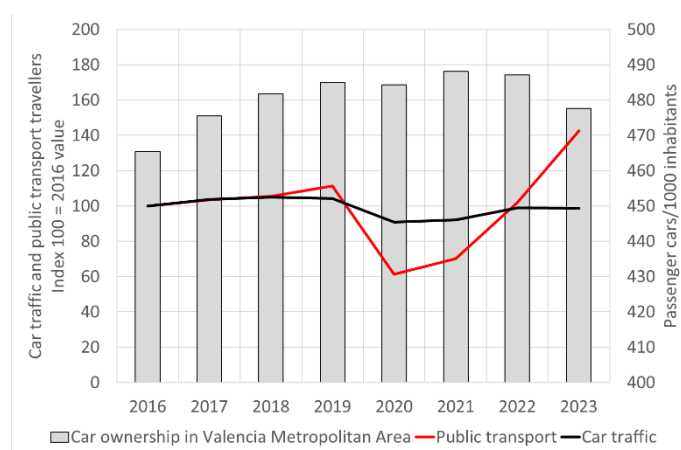


Figure 6. Mobility trends on a metropolitan scale in the VMA. Data source: Valencia City Council (2024a, 2024b) and General Directorate of Traffic (2024).

Table 7. Public transport and private car use in daily motorised trips between Valencia and its metropolitan area (2016-2023). Data source: Valencia City Council (2024a, 2024b).

	2016	2017	2018	2019	2020	2021	2022	2023
By car (thousands)	360	374	379	375	328	332	356	356
By public Transport (thousands)	81	83	85	90	50	57	82	115
Total (thousands)	441	457	464	465	377	389	439	471
% by public transport	18.3%	18.2%	18.4%	19.3%	13.1%	14.6%	18.8%	24.4%

4.4 Socio-demographic changes

There are several other conditioning factors underpinning the observed trends of reduced car dependency. Among these, the role that social, socio-demographic or technological processes might play is discussed here.

One factor that is often mentioned is the introduction of teleworking, which reduces the demand for mobility all together, not just by car. The only available data on teleworking comes from the National Statistical Institute, which provides provincial-level figures for the past three years. According to this, in 2023, 37.6% of employees were engaged in partial or full-time remote work, marking a slight increase from 2022. This proportion is likely higher than pre-pandemic levels, though precise figures remain unknown. Despite this, total mobility in 2023 has already returned to pre-pandemic levels, suggesting that the impact of teleworking on overall transport demand may be limited or confined to specific groups of workers.

Recent changes in the socio-demographic composition of the population, driven by both ageing and migration, play a role. On the one hand, ageing is typically associated with lower car usage due to the physical limitations of older people and a general tendency for reduced mobility among older adults. Similarly, immigrant populations often exhibit different mobility patterns compared to native residents, which tends to be associated with lower rates of car ownership and usage. The recent evolution of these two variables (Tables 8 and 9) suggests a modest decline in car dependency, especially within the inner conurbation.

Table 8. Population aged 65 and above (2015–2023). Data source: National Statistical Institute (2024a).

	2015	2019	2021	2023	Δ 2015-2023
Central city	19.9%	20.9%	21.4%	21.5%	+ 1.6%
Inner conurbation	15.4%	16.6%	17.1%	17.6%	+2.3%
Outer functional area	16.3%	17.4%	17.8%	18.2%	+1.9%
Valencia Metropolitan Area	17.5%	18.6%	19.0%	19.3%	+1.8%

Table 9. Foreign immigrant population (2015–2023). Data source: National Statistical Institute (2024a).

	2015	2019	2021	2023	Δ 2015-2023
Central city	11.9 %	12.8 %	13.3 %	15.9 %	+4.0 %
Inner conurbation	7.6 %	8.4 %	9.6 %	11.8 %	+4.1 %
Outer functional area	8.2 %	8.6 %	9.8 %	11.6 %	+3.4 %
Valencia Metropolitan Area	9.5 %	10.2 %	11.1 %	13.3 %	+3.8 %

Table 10. Population aged 18 and above with a driving licence (2015–2023).
Data source: General Directorate of Traffic (2024).

	2015	2019	2021	2023	Δ 2015-2023
Central city	68.5 %	68.8 %	68.5 %	67.6 %	-0.9 %
Inner conurbation	71.5 %	72.8 %	71.7 %	70.6 %	-1.0 %
Outer functional area	73.5 %	75.4 %	74.4 %	73.6 %	+0.1 %
Valencia Metropolitan Area	70.8 %	71.9 %	71.2 %	70.3 %	-0.5 %

Finally, the declining propensity to obtain and renew driving licences, often influenced by sociological factors beyond transportation needs, is another key factor influencing mobility trends. In Spain, the proportion of the population aged 18–24 with a driving licence has fallen from 62% in 2009 to just 49% in 2023, a trend observed in both men and women (General Directorate of Traffic, 2024). This shift suggests that a segment of younger adults, shaped by evolving consumption patterns and cultural values, may never become regular drivers. This is consistent with results from other studies, which suggest that young adults are a key demographic contributing to the reduction in per capita car use (Garikapati et al., 2016; van der Waard, 2013). In the VMA (Table 10), this lower propensity to obtain a driving licence is also observed, particularly in central areas. Although the decline appears small, its long-term impact is amplified by demographic inertia, as generational shifts take time to manifest in broader mobility patterns.

5. Discussion

The differences in car ownership between metropolitan areas cannot be satisfactorily explained solely by economic development or income levels. On the contrary, the factors that influence car ownership are primarily territorial. A comparison of Madrid and Barcelona in Spain provides valuable insight into this issue. In Barcelona, urban sprawl has been more effectively contained, leading to greater density and better preservation of various sub-centres of activity, both within the central city and at metropolitan level. As a result, the dynamics of proximity are more pronounced in Barcelona, promoting a more sustainable modal split and reducing car dependency (see Table 3). This confirms the importance of conducting case studies in specific metropolitan areas to fully understand the spread of the peak-car phenomenon. Generalised global perspectives, often framed at the national level, may obscure the processes occurring at the local level, rendering them almost invisible. In this regard, Wittwer et al. (2019) studied the peak-car phenomenon in several cities, including Berlin, Copenhagen, London, Paris, and Vienna using household travel surveys to uncover interesting trends. They observed that car use peaked in Paris in the early 1990s, in Berlin, London, and Vienna in the late 1990s, and in Copenhagen in the late 2000s. The study further found that differences in overall trip numbers were primarily attributed to a shift towards public transport, cycling, and walking. Similarly, in Valencia, the most central and densely populated intra-metropolitan areas, which typically offer better alternative transport options and facilitate cycling and walking, are at the forefront of this shift, while the suburbs remain more reliant on car use. It is therefore crucial that private car use begins to decline in these peripheral areas as well. This territorial pattern is evident both in terms of car ownership (private cars per 1,000 inhabitants) and car use (road traffic intensity).

Moreover, the evidence we have collected reveals that the relationship between car use and the economic cycle has changed significantly over the past decade. Traditionally, economic growth was associated with an increase in traffic, while downturns were linked to periods of crisis. Consequently, fluctuations in car use and ownership were often interpreted as temporary, cyclical trends. However, we are now observing a decoupling of these dynamics. This trend began during the economic recovery phase after 2013 and has intensified since 2018. Even highly disruptive events, such as the COVID-19 pandemic, have not interrupted what appears to be a strong, underlying trend of declining car use. The

trajectory of the Valencia metropolitan area thus provides empirical evidence to support the peak-car hypothesis, both in terms of car ownership and private car use. Interestingly, the decline in car use appears to precede the decline in car ownership, with a gap of three to five years between the two processes. This gap is larger in the central city, where the decline in traffic began earlier, compared to the suburbs, where residents are more reluctant to abandon car use.

If the economic cycle no longer provides a sufficient explanation for these trends, a broader range of factors—territorial, cultural, socio-demographic, and political—must be explored to understand the ongoing processes. At the same time, territorial variations within the metropolitan area will offer insights into these dynamics. A key set of factors includes socio-cultural and behavioural changes. In this context, the decline in the proportion of the adult population holding a driving licence is striking, representing a long-term trend, particularly pronounced in the central city and inner conurbation. Additionally, the rise in the number of foreign migrant residents, which is higher in the central areas of the agglomeration, also contributes to reduced car use: this group is less likely to own a car and more likely to utilise public transport. Finally, another long-term trend, the ageing of the population, also contributes to a reduction in car use, both in terms of frequency and distance travelled.

While these socio-demographic trends support the overall shift away from car use, they alone do not fully account for the recent decline in car use and ownership. The changes observed since 2015 are too small to provide a comprehensive explanation. Similarly, recent developments in residential densities offer limited insight. The recent increase in densities, primarily driven by population growth and resumed immigration since 2021, has not been sufficient to reverse the extensive urban sprawl that occurred between 1990 and 2008. Thus, the peak-car phenomenon we are witnessing is occurring within an urban landscape built around and for the private car, which previously promoted the use of the private car until 2015.

Finally, the recent increase in public transport ridership aligns with the general growth in urban mobility. While private car use has stabilised at levels below pre-COVID numbers, public transport has absorbed much of the increase in travel. However, this shift is taking place without a corresponding increase in network capacity, whether in terms of infrastructure or rolling stock, leading to severe congestion and greater inconvenience for users. In fact, the only improvements to the network in the past decade have been focused on tram lines within the city of Valencia, with little attention given to the metropolitan area. Despite the limited recent improvements to public transport, the transfer of trips to this mode takes advantage of previous investments and the underutilised transport capacity created by the 2008 crisis and the COVID-19 disruptions. Given the inadequacy of economic, territorial, or socio-demographic factors alone to explain the reduction in car use, the role of mobility policies—particularly those related to public transport—is crucial.

6. The role of mobility policies: past, present and future

Prior to 2015, the mobility policy in the VMA primarily focused on the development of a metropolitan railway network (Metrovalencia) through the modernisation and extension of the existing metric-gauge railway network, which dated back to the early 20th century. Significant milestones in this process included the underground connection between lines in 1988, the restoration of the tramway in 1994 (the first in Spain), and the extension of a new line to the airport in 2007. These developments enabled the high-capacity urban transport system to grow from 7 million passengers in 1986 to 24 million in 1998 and 68 million in 2008. However, despite this substantial commitment to public transport, the sprawling growth of the metropolitan since 1990 has led to a surge in private car use and the expansion of the motorway network, with little progress made in achieving a more sustainable modal split. The lack of effective metropolitan governance in both mobility and land-use planning, as evidenced by the absence of an independent metropolitan authority with executive powers, hindered further progress in this direction (Tomás & Porfido, 2024). The economic crisis that began in 2008 had a significant impact, leading to budget cuts, a reduction in public transport services, and a 10% decline in demand, while all expansion plans were put on hold.

In May 2015, a turning point in mobility policies occurred with a change of government, as left-wing and environmentalist coalitions took office in both in the city of Valencia and at the regional level, ending more than two decades of conservative political dominance. Mobility policy became one of the key features of the new political cycle (Baron, 2019), marking a radical shift towards promoting active mobility and the use of public transport at the expense of private car use. Several key milestones defined this new policy direction and contributed to the decline in traffic observed since 2015. Among these, the following should be highlighted:

- 2015: Extension of Metrovalencia Line 9 between Manises and Ribarroja.
- 2015–2017: Recovery of the Valencia Metropolitan Transport Authority, the body responsible for coordinating and integrating fares across the different public transport modes serving the VMA.
- March 2017: Opening of the “cycling ring” around the first ring road in the historic centre of Valencia, a cycle lane that integrates the entire cycling network in the city. In addition, the Valencia cycling network was extended from 133 to 190 km, largely with support from European Union funding, and with improved quality and safety standards.
- May 2017: Ban on parking in the bus lane at night (22:00–8:00) in the city of Valencia.
- June 2019: Declaration of Valencia as a “City 30”, reducing the speed limit to 30 km/h (previously 50 km/h) on all roads with only one lane in each direction, and on other roads in the city centre, affecting 64% of the city's road network.
- 2016–2022: Gradual integration of public transport fares, culminating in 2022 with the introduction of a single ticket for all modes of transport (metro, tram, train, and bus), offering significant cost savings for users.
- January 2022: Re-regulation of private car parking on the streets through the introduction of new zones (green and orange), reserving parking spaces for residents only.
- May 2022: Opening of Line 10 of the Metrovalencia tram network, the first extension since 2015.
- June 2022: Presentation of the first Metropolitan Mobility Plan, outlining the main strategic lines to improve intermodality and sustainable mobility in the city.
- 2023–2024: Additional measures in response to the inflationary crisis to reduce the price of public transport, including some services being made free.

These policies have transformed the city of Valencia into an increasingly car-unfriendly environment, while facilitating safe mobility by bicycle and reducing the cost of public transport. Housing densities have increased, but far more crucial for achieving sustainability goals are other urban design elements, such as the reconfiguration of public space. This shift has altered the metrics of public spaces to create accessible and safe environments where active mobility can flourish (Grosvenor & O'Neill, 2014). The intensity and persistence of these policies throughout the eight years of progressive governments (2015–2023) appear to have had a clear impact. During this period, the city of Valencia has made substantial

progress towards more sustainable, active, and less carbon-intensive mobility. What may happen following the change in local government in 2023 remains uncertain, although it is hoped that the underlying trends are strong enough to persist beyond the political shift.

Looking to the future of mobility policies, it is clear that further improvements are needed. Their impact could have been greater had more far-reaching measures been implemented, such as the establishment of a Low Emission Zone (LEZ) in Valencia to restrict traffic and preserve air quality. Although Spain's Climate Change and Energy Transition Law (2021) mandates that all cities with over 50,000 inhabitants must implement a LEZ in place by 1 January 2025, Valencia has yet to meet this requirement. In fact, Valencia is the only Spanish city with over 500,000 inhabitants that has not yet implemented a LEZ. The recently presented LEZ project lacks ambition, as it will not be fully implemented until 2028.

Furthermore, the lack of public resources has hindered the expansion of public transport to keep pace with rising demand. Between 2019 and 2023, the supply of public transport (measured in seat-km per inhabitant per year) decreased by 6%, while demand increased by 16% (Metropolitan Mobility Observatory, 2023). Public transport in cities has faced increasing pressure in recent years, partly due to policies encouraging its use. However, unless the public sector can provide the necessary resources to match this success, a crucial opportunity to accelerate the transition to more sustainable, low-carbon, and car-free mobility will be missed. Despite the funding challenges faced by local and regional authorities, now is the most opportune time to expand the network in response to increasing demand. Current plans to improve infrastructure and increase frequency are undoubtedly timely. This is particularly critical in the wake of the significant damage caused by the floods of 29 October 2024, which severely affected the southern VMA, resulting in losses of €17 billion and 224 fatalities (Perez et al., 2025). Among other impacts, the floods nearly destroyed the car fleet in the affected municipalities (around 128,000 cars), as well as the entire Metrovalencia railway network in the affected area, which is not expected to be rebuilt and reopened until the summer of 2025. Despite the human tragedy of the floods, there is now a window of opportunity if the reconstruction prioritises the public transport network and if economic aid to those who lost their cars is not contingent on purchasing a new one.

7. Conclusions

Some tentative conclusions can be drawn from the findings presented above. First, the evidence gathered from our case study highlights the ongoing relevance of the peak-car concept, especially when applied to urban areas and, more specifically, to their most central and densely populated spaces. These metropolitan areas are at the forefront of the shift away from the private car as the dominant mode of transport. This transition follows a temporal sequence in which younger generations first exhibit a lower propensity to obtain and maintain a driving licence, followed by a decline in car use, and ultimately, a reduction in motorisation rates.

Furthermore, the recent decline in car use and ownership since 2015 has occurred against a backdrop of economic and employment growth, meaning it cannot be attributed, as in the past, solely to fluctuations in the economic cycle. The decoupling of economic variables from car use is becoming increasingly evident, a trend that remains unbroken even in the face of potentially disruptive events, such as the COVID-19 pandemic. Consequently, the first hypothesis put forward to explain the peak in car use, which is of an economic nature, seems to lose its validity. In contrast, the second hypothesis, which focuses on the concept of mobility saturation, does not appear to be applicable in our case either. This is because the decline in the relative importance of car use occurs simultaneously with an increase in overall mobility, which is reaching new records. The saturation hypothesis is likely more relevant to larger and more mature metropolitan areas, such as Madrid and Barcelona, than to Valencia, where the distances travelled and the frequency of daily trips still have significant room for growth. According to Kuhnimhof et al. (2013), car travel per capita in France and the United States is strongly linked to changes in total travel demand. However, in Germany and the United Kingdom, the decline in car use is more closely associated with the levelling off of motorisation and a shift to other modes of transport. This observation aligns with trends in Valencia, where travel demand has continued to increase, yet it is not the car that has absorbed this growth.

These points lead us to support the third hypothesis to explain the peak in car use: we are witnessing a shift in the mobility model, driven by new socio-demographic and technological factors, coupled with a new territorial model that is more conducive to active mobility. This is further reinforced by a series of policies that promote sustainable transport. In this context, although many of the factors contributing to the reduction in car use appear to be moving in the right direction, their evolution alone is not robust enough to account for the change. Factors such as the ageing population, the weight of migrant populations, and urban form change gradually and have considerable inertia. It is here that the influence of public policies on urban space design becomes pivotal. Such policies help create an urban fabric that is either more or less car-friendly, encouraging the use of alternative modes of transport, including active mobility, cycling, and high-capacity public transport. The case of Valencia demonstrates the power of persistent and focused local and regional policies. These policies can succeed even in a context of limited public resources, concentrating on low-cost measures to modify and regulate the use of public space. However, such policies are not without risk, as they can provoke widespread opposition within the local community and become the focus of intense political struggles that extend beyond purely rational debates.

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References

- Albertos, J. M. (2014). La movilidad sostenible en áreas metropolitanas. Evolución reciente y escenarios de futuro en el Área Metropolitana de Valencia. In M.D. Pitarch (dir.), *Sostenibilidad en las áreas metropolitanas*, 63-80. IIDL-PUV, Universitat de València.
- Baron, N. (2019). Bike mobilities, democratic revival and the local fix. Valencia, from corruption epicentre to Mediterranean cycle capital, *Belgeo*, 4, 1-22. <https://doi.org/10.4000/belgeo.36436>
- Bartzokas-Tsiompras, A. (2022). "Utilizing OpenStreetMap Data to Measure and Compare Pedestrian Street Lengths in 992 Cities Around the World". *European Journal of Geography* 13(2), 127-141. <https://doi.org/10.48088/ejg.a.bar.13.2.127.138>
- Bartzokas-Tsiompras, A. & Bakogiannis, E. (2023). Quantifying and visualizing the 15-Minute walkable city concept across Europe: a multicriteria approach, *Journal of Maps*, 19(1), 2141143. <https://doi.org/10.1080/17445647.2022.2141143>
- Bastian, A, Börjesson, M., & Eliasson, J. (2016). Explaining peak-car with economic variables, *Transportation Research Part A*, 88, 236–250. <http://dx.doi.org/10.1016/j.tra.2016.04.005>
- Bretagnolle, A. (2009). Villes et réseaux de transport : des interactions dans la longue durée (France, Europe, États-Unis). Université Pantheon-Sorbonne - Paris I. <https://theses.hal.science/tel-00459720>
- Burriel, E. L. (2008). La "década prodigiosa" del urbanismo español (1997-2006). *Scripta Nova*, 12. <https://revistes.ub.edu/index.php/ScriptaNova/article/view/1489>
- Cervero, R. & Kockelman, K. (1997). Travel demand and the 3Ds: Density, diversity, and design, *Transportation Research Part D: Transport and Environment*, 2(3), 199-219. [https://doi.org/10.1016/S1361-9209\(97\)00009-6](https://doi.org/10.1016/S1361-9209(97)00009-6)
- Delbosc A. & Currie, G. (2013). Causes of Youth Licensing Decline: A Synthesis of Evidence, *Transport Reviews*, 33(3), 271-290. <https://doi.org/10.1080/01441647.2013.801929>
- Dupuy, G. (1995). *Les territoires de l'automobile*. Anthropos/Economica.
- Escolano, S., López, C & Salvador (2024), Size and spatial and functional structure of aggregate daily mobility networks in functional urban areas: Integrating adjacent spaces at several scales, *Cities*, 145, 104731. <https://doi.org/10.1016/j.cities.2023.104731>
- EUROSTAT (2017). *European cities – the EU-OECD functional urban area definition*, Eurostat statistics explained. EUROSTAT. https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Archive:European_cities_%E2%80%93_the_EU-OECD_functional_urban_area_definition
- Feria, J. M. (2013). Towards a taxonomy of Spanish metropolitan areas, *Boletín de la Asociación De Geógrafos Españoles*, 63, 349-378. <https://www.bage.age-geografia.es/ojs/index.php/bage/article/view/1635>
- Feria, J.M., De Oliveira, G. & Hurtado, C. (2018) Une méthode pour la délimitation des aires métropolitaines en Espagne. *Cybergeogeo*. 852 <https://doi.org/10.4000/cybergeogeo.29101>
- Focas, C., & Christidis, P. (2017). Peak-car in Europe?, *Transportation Research Procedia*, 25, 531–550. <http://doi.org/10.1016/j.trpro.2017.05.437>
- Garikapati V. M., Pendyala R. M., Morris E. A., Mokhtarian P. L. & McDonald, N. (2016) Activity Patterns, Time Use, and Travel of Millennials. A Generation in Transition?, *Transport Reviews*, 36(5), 558–584. <https://doi.org/10.1080/01441647.2016.1197337>
- General Directorate of Traffic (2024). *Datos municipales. Información general*, Dirección General de Tráfico. <https://www.dgt.es/menusecundario/dgt-en-cifras/>
- General Directorate of Cadastre (2024). *Municipal cadastral statistics*. Dirección General del Catastro. <https://www.catastro.hacienda.gob.es/esp/estadisticas.asp>
- Goodwin, P. (2011). Three views on 'Peak-car', *World Transport Policy y Practice*, 17(4), 8-17.
- Goodwin, P. (2012). *Peak Travel, Peak-car and the Future of Mobility*, Discussion Paper Nº. 2012-12, OECD/International Transport Forum. <https://doi.org/10.1787/2223439X>
- Grosvenor, M. & O'Neill, P. (2014). The Density Debate in Urban Research: An Alternative Approach to Representing Urban Structure and Form, *Geographical Review*, 52(4), 442–458. <http://doi:10.1111/1745-5871.12084>
- Gutiérrez-Puebla, J., & García-Palomares, J. C. (2005). Cambios en la movilidad en el área metropolitana de Madrid: el creciente uso del transporte privado. *Anales de Geografía de La Universidad Complutense*, 25, 331–351. <https://revistas.ucm.es/index.php/AGUC/article/view/AGUC0505110331A/31014>
- Gutiérrez-Puebla, J., & García-Palomares, J. C. (2007). New spatial patterns of mobility within the metropolitan area of Madrid: Towards more complex and dispersed flow networks. *Journal of Transport Geography*, 15(1), 18–30. <https://doi.org/10.1016/j.jtrangeo.2006.01.002>
- Hjorthol, R. (2016) Decreasing Popularity of the Car? Changes in Driving Licence and Access to a Car among Young Adults Over a 25-year Period in Norway, *Journal of Transport Geography*, 51, 140–146. <https://doi.org/10.1016/j.jtrangeo.2015.12.006>
- IPCC (2023). *Climate Change 2023: Synthesis Report. Contribution of Working Groups I, II and III to the Sixth. Assessment Report of the Intergovernmental Panel on Climate Change*, IPCC. <http://doi.org/10.59327/IPCC/AR6-9789291691647>
- ITF (2013). *Long Run Trends in Car Use*. ITF Round Tables 152, OECD Publishing/International Transport Forum. <https://doi.org/10.1787/9789282105931-en>
- Kuhnimhof T., Zumkeller D., Chlond B. (2013). Who Made Peak Car, and How? A Breakdown of Trends over Four Decades in Four Countries. *Transport Reviews*, 33(3), 325–342. <https://doi.org/10.1080/01441647.2013.801928>
- Lee-Gosselin, M. E. H. (2017). Beyond "Peak-car": A reflection on the evolution of public sentiment about the role of cars in cities, *IATSS Research*, 40, 85–87. <http://dx.doi.org/10.1016/j.iatssr.2016.05.004>
- Litman, T.A. (2017). *Understanding Transport Demands and Elasticities*, Victoria Transport Policy Institute. <https://www.vtpi.org/tdm/tdm11.htm>
- Maestro, I. & Albertos, J.M. (2017). Reparto modal y eficiencia comparada de modos de transporte en el Área Metropolitana de Valencia. Hacia una movilidad más sostenible. In M. D. Pitarch (dir.), *Estructura, vida y gobierno en territorios complejos*, 149-180. Tirant Humanidades.
- Marquet, O. & Miralles, C. (2017). Efectos de la crisis económica en la movilidad cotidiana de la región metropolitana de Barcelona, *Boletín de la Asociación de Geógrafos Españoles*, 75, 9-28. <https://doi.org/10.21138/bage.2490>
- Miralles, C. (2002). *Ciudad y Transporte. El binomio imperfecto*. Ariel Geografía.

- Metz, D. (2010). Saturation of demand for daily travel, *Transport Reviews*, 30(5), 659-674. <https://doi.org/10.1080/01441640903556361>
- Metz, D. (2012). Demographic determinants of daily travel demand. *Transport Policy*, 21, 20-25. <https://doi.org/10.1016/j.tranpol.2012.01.007>
- Metz, D. (2013). Peak-car and Beyond: The Fourth Era of Travel. *Transport Reviews*, 33(3), 255-270. <https://doi.org/10.1080/01441647.2013.800615>
- Millard-Ball, A., & Schipper, L. (2011). Are we reaching peak travel? Trends in passenger transport in eight industrialized countries. *Transport Reviews*, 31(3), 357-378. <https://doi.org/10.1080/01441647.2010.518291>
- Monclus, F. J. (1998). *La ciudad dispersa: suburbanización y nuevas periferias*. Centre de Cultura Contemporània de Barcelona.
- Moreno, C. (2020). *Droit de la cité. De la "ville monde" à la "ville du quart d'heure"*, Éditions de l'Observatoire/Humensis.
- National Statistical Institute (2024a). *Continuous Population Statistics*, Instituto Nacional de Estadística. https://www.ine.es/dyngs/INEbase/en/categoria.htm?c=Estadistica_P&cid=1254734710984
- National Statistical Institute (2024b). *Spanish Regional Accounts*. Instituto Nacional de Estadística. https://www.ine.es/dyngs/INEbase/en/categoria.htm?c=Estadistica_P&cid=1254735570541
- National Statistical Institute (2024c). *Economically Active Population Survey*. Instituto Nacional de Estadística. https://www.ine.es/dyngs/INEbase/en/categoria.htm?c=Estadistica_P&cid=1254735976594
- Metropolitan Mobility Observatory (2023). *Informe julio 2023 (Datos 2021-Avance 2022)*, Observatorio de la Movilidad Metropolitana. <https://observatoriomovilidad.es/informes/>
- Olde, M.J., Geurms K.T. & Wismans, L. (2021). Post COVID-19 teleworking and car use intentions. Evidence from large scale GPS-tracking and survey data in the Netherlands. *Transportation Research Interdisciplinary Perspectives*, 12, 1-11. <https://doi.org/10.1016/j.trip.2021.100498>
- Paul, J. & Blumenberg, E. (2023). Vehicle ownership rates: The role of lifecycle, period, and cohort effects. *Transportation Research Interdisciplinary Perspectives*, 21, 1-11. <https://doi.org/10.1016/j.trip.2023.100892>
- Pérez, F., J. Maudos, F. J. Goerlich, E. Reig, P. Chorén, J.C. Robledo, C. Albert, H. García y G. Bravo (2025). Alcance económico de la dana del 29 de octubre en la provincia de Valencia. València: Generalitat Valenciana: Ivie. https://www.ivie.es/es_ES/ptproyecto/ivielab-alcance-economico-de-la-dana-del-29-de-octubre-en-la-provincia-de-valencia/
- Robinson, J. (2006). *Ordinary Cities. Between Modernity and Development*, Routledge.
- Romero, J. (2010). Construcción residencial y gobierno del territorio en España. De la burbuja especulativa a la recesión. Causas y consecuencias. *Cuadernos Geográficos*, 47, 17–46. <https://revistaseug.ugr.es/index.php/cuadgeo/article/view/600>
- Romero, J., Brandis, D., Delgado Viñas, C., García Rodríguez, J. L., Gómez Moreno, M. L., Olcina, J., Rullán, O., Vera-Rebollo, J. F., & Vicente Rufí, J. (2018). Aproximación a la Geografía del despilfarro en España: balance de las últimas dos décadas. *Boletín de la Asociación de Geógrafos Españoles*, 77, 1–51. <http://dx.doi.org/10.21138/bage.2533>
- Schipper, L., Steiner, R., Figueroa, M. J. & Dolan, K. (1993). Fuel prices and economy factors affecting land-travel. *Transport Policy*, 1(1), 6-20. [https://doi.org/10.1016/0967-070X\(93\)90003-6](https://doi.org/10.1016/0967-070X(93)90003-6)
- Sheller, M., & Urry, J. (2006). The new mobilities paradigm. *Environment and Planning A: Economy and Space*, 38(2), 207–226. <https://doi.org/10.1068/a37268>
- Tomàs, M. (2023). *Metrópolis sin gobierno. La anomalía española en Europa*. Tirant lo Blanc.
- Tomàs, M., & Porfido, E. (2024). La gobernanza de la movilidad en España: un enfoque metropolitano. *Ciudad y Territorio Estudios Territoriales*, 56(222), 1153–1172. <https://doi.org/10.37230/CyTET.2024.222.4>
- Valencia City Council (2024a). *Daily average intensity maps. Bicycles and motorized vehicles*, Ayuntamiento de Valencia. <https://www.valencia.es/val/mobilitat/altres-descarregues>
- Valencia City Council (2024b). *Municipal Statistical Yearbook*, Ayuntamiento de Valencia. <https://www.valencia.es/cas/estadistica/catalogo-de-publicaciones>
- van der Waard J., Jorritsma P. & Immers B. (2013) New Drivers in Mobility; What Moves the Dutch in 2012? *Transport Reviews*, 33(3), 343–359. <https://doi.org/10.1080/01441647.2013.801046>
- Wittwer, R., Gerike, R., & Hubrich, S. (2019). Peak-Car Phenomenon Revisited for Urban Areas: Microdata Analysis of Household Travel Surveys from Five European Capital Cities, *Transportation Research Record*, 2673(3), 686-699. <https://doi.org/10.1177/0361198119835509>
- Zahavi, Y. (1974). *Travel time budgets and the mobility in urban areas. Final report*, U.S. Department of Transportation. <https://rosap.nhtl.bts.gov/view/dot/12144>
- Zornoza, C. (2022). Means of Transport and Population Distribution in Metropolitan Areas: An Evolutionary Analysis of the Valencia Metropolitan Area. *Land*, 11(5) 657, 1-18. <https://doi.org/10.3390/land11050657>

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