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Article

Public policies and sustainable mobility in Spain: empirical analysis of household expenditure on bicycles

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Abstract. This study investigates the socioeconomic determinants of household expenditure on sports bicycles in Spain, providing novel insights into the affordability and equity dimensions of sustainable mobility policies. Whilst cycling promotion has emerged as a central pillar of urban and environmental strategies, the economic factors influencing household-level bicycle adoption remain under-researched, particularly within Southern European contexts. Employing nationally representative microdata and a two-part modelling approach, this analysis explores how income, household characteristics and regional variations shape cycling-related expenditure patterns. The findings demonstrate that bicycle expenditure has become progressively concentrated among higher-income households, suggesting an evolution towards cycling being perceived as a discretionary purchase rather than an accessible transport solution. Persistent disparities are observed across age groups, family structures and geographical regions, highlighting unequal access to the benefits of cycling. This research challenges prevailing assumptions regarding the inherent affordability of cycling and proposes targeted policy interventions to mitigate financial and structural barriers. By connecting macro-level sustainability objectives with micro-level consumption behaviour, this study contributes a conceptual framework for developing inclusive mobility policies that balance environmental ambitions with social equity considerations. The analysis offers timely evidence for policymakers seeking to align Spain's cycling strategy with principles of distributive justice and broader sustainable development goals.

Keywords: cycling policy; economic policy; household expenditure; sustainable mobility
JEL classification:

1. Introduction

The promotion of sustainable lifestyles, in line with the Paris Agreement's climate targets, is critical to limiting global warming to well below 2°C, with an aspirational goal of 1.5°C (IPCC, 2018). Sustainable mobility plays a central role in this effort due to its capacity to reduce transport-related carbon emissions (Creutzig et al., 2015). Low-emission transport modes, enhanced public transport, and the adoption of electric vehicles are frequently cited as key tools for climate mitigation (Sims et al., 2014; IPCC, 2022). Within this framework, cycling has gained prominence as a cost-effective,

health-promoting, and low-carbon mode of urban transport (Pucher & Buehler, 2017).

Beyond its environmental contribution, cycling also offers social and economic benefits. In sport economics, bicycles are recognised as both recreational and functional consumer goods. According to the Sports Habits Survey (2022), 54.3% of the Spanish population own a bicycle, a proportion rising to 66.4% among individuals who have engaged in sport during the past year. This data underscores the role of bicycles as key components of physically active lifestyles.

Public policy interventions, such as infrastructure investment, purchase subsidies, and bike-sharing systems, have fostered the growth of cycling in many urban areas (Gössling & Choi, 2015). Empirical evidence from European cities shows that cycling infrastructure not only increases ridership but also mitigates congestion and emissions (Fishman, 2015).

In Spain, cycling has shifted from a leisure activity to a mainstream mobility option, supported by increasing environmental awareness and improved infrastructure (Observatorio de la Bicicleta en España, 2022; Muñoz et al., 2013). Higher cycling rates have been linked to public health gains through increased physical activity and improved air quality (de Nazelle et al., 2011).

In recent years, national and regional authorities have intensified their efforts to promote cycling through dedicated strategies and funding (Ministry for Ecological Transition and the Demographic Challenge, 2023). Nevertheless, the implementation of these policies remains uneven across administrative levels, and limited evidence exists on their economic impact, particularly regarding household-level bicycle spending.

This paper contributes to filling this gap by empirically analysing the determinants of household bicycle expenditure in Spain, with particular attention to its income elasticity. The findings aim to shed light on the economic barriers and facilitators affecting bicycle acquisition and use. Since bicycle ownership is a prerequisite for both utilitarian and recreational cycling, understanding these patterns is critical for policy design in the areas of transport, health, and sustainability.

Furthermore, it should be noted that the empirical strategy integrates economic (Becker, 1964; McFadden, 1974), psychosocial (Ajzen, 1991), and environmental-political (Bronfenbrenner, 1979) frameworks, offering a multidimensional approach to analysing consumer behaviour in the cycling sector.

2. Literature review

Cycling is widely recognised as a key component of sustainable mobility, particularly in its potential to reduce greenhouse gas emissions and support public health objectives (Creutzig et al., 2015; Sims et al., 2014). However, despite the extensive literature on infrastructure investment, modal choice, and behavioural determinants of cycling, relatively few studies have focused on household expenditure on bicycles, especially within European economies. Understanding household spending behaviour is crucial for evaluating the distributive effects of cycling policies and for designing interventions that are both efficient and equitable.

From an economic perspective, household expenditure on bicycles can be conceptualised as an investment in health and human capital. According to Becker (1964), individuals allocate resources to improve their long-term productivity and well-being. In this framework, bicycles

represent durable goods that facilitate regular physical activity, thereby contributing to improved health outcomes and potentially reducing future healthcare costs. This justifies the inclusion of bicycle-related spending within broader analyses of health-oriented consumption and the effectiveness of preventive public policy.

Transport economics offers a complementary framework. Based on the random utility model developed by McFadden (1974), households choose among transport modes by maximising expected utility, which depends on costs, time, convenience, and preferences. Bicycle purchases reflect the relative utility of cycling compared to other modes, and this utility is shaped by contextual variables such as infrastructure availability, fuel prices, or perceived safety. Policy instruments that alter these parameters, such as cycle lanes, intermodality schemes, or car disincentives, can directly affect both the probability and magnitude of bicycle-related expenditure.

In addition, psychosocial factors influence consumption decisions. Ajzen's (1991) Theory of Planned Behaviour identifies attitudes, subjective norms, and perceived behavioural control as predictors of intentional behaviour. Households are more likely to invest in bicycles when they associate cycling with health, environmental responsibility, or social desirability, and when they feel capable of cycling safely in their environment. This implies that public policy must go beyond cost reduction and also address informational, cultural, and social barriers through awareness campaigns and community-based programmes.

The ecological systems theory of Bronfenbrenner (1979) provides a useful framework for analysing the interaction between individual decisions and the institutional and environmental contexts in which they occur. From this perspective, spending on bicycles is not only determined by personal attributes such as income or education, but also by variables such as the built environment, political support and social norms. Public interventions, such as subsidies, regulation, or investment in infrastructure, influence household behaviour through direct and indirect channels.

Finally, the diffusion of innovations framework (Rogers, 1962) explains how new behaviours and consumption patterns spread across populations. In the case of cycling, symbolic associations with modernity, sustainability, or well-being may accelerate adoption, particularly among early adopters in urban areas. Public authorities can leverage this dynamic through framing and communication strategies that present bicycles as aspirational goods aligned with contemporary lifestyle values.

The limited empirical literature on bicycle expenditure confirms the relevance of these theoretical insights. Thibaut et al. (2016), analysing Belgian survey data, show that spending is influenced not only by demographics but also by cycling frequency, type of use, and online engagement. Their concept of cycling capital, as a composite of identity, competence, and habit, demonstrates that behavioural and cultural factors are critical determinants of expenditure.

Environmental and spatial factors are also empirically significant. Zhang et al. (2024) indicates that urban design, infrastructure quality, and perceived safety are strong predictors of cycling frequency and related expenditure. Furthermore, access to shared bicycle systems can produce spillover effects on household transport behaviour and leisure-related consumption.

Despite these contributions, evidence for the Spanish context remains scarce. Most existing studies are situated in countries with consolidated cycling cultures and relatively homogeneous infrastructure. Moreover, few papers analyse household-level bicycle expenditure using microdata,

or explore its elasticity with respect to income and other structural variables. This gap is particularly relevant in light of recent policy efforts to promote active mobility in Spain, which require evidence-based evaluation of their economic and behavioural impacts.

This paper addresses these gaps by estimating a two-part model of household bicycle expenditure using Spanish microdata. By linking expenditure decisions to sociodemographic, geographic, and behavioural variables, by explicitly estimating income elasticity, the study contributes to a better understanding of the economic drivers of active mobility and provides empirical evidence to support the design of equitable and effective public policy.

3. Data and variables

The data used in this analysis come from the Household Budget Surveys (Encuestas de Presupuestos Familiares, EPF) conducted by the Spanish National Statistics Institute (Instituto Nacional de Estadística, INE). These surveys collect detailed information on private household expenditures, enabling the analysis of consumption trends across various goods and services. To identify goods and services specifically related to bicycles, we employed the European Classification of Individual Consumption by Purpose (ECOICOP) at its most disaggregated level. In particular, bicycle-related expenditures were grouped following the same classification criterion used in the Spanish Yearbook of Sports Statistics, which associates household spending on sports with code 07130.

A methodological clarification is warranted regarding the scope of our expenditure variable. The ECOICOP code 07130 specifically captures expenditure on 'sports bicycles'. While this classification may encompass some bicycles used for utilitarian purposes, it primarily reflects recreational cycling consumption. This distinction is crucial for interpreting our findings, as the socioeconomic determinants and income elasticity of sports bicycle expenditure may differ substantively from those of strictly utilitarian bicycles, which are often lower-cost purchases for daily transport needs.

Furthermore, it is important to note that this category refers exclusively to conventional non-motorised bicycles. Electric bicycles (e-bikes) are classified separately under a different expenditure code together with other motorised two-wheeled vehicles. This focused approach ensures conceptual consistency with active mobility while acknowledging that future research could benefit from analysing e-bike expenditure separately as statistical classifications evolve.

For the empirical analysis, this study focuses on two reference years: 2019 and 2023. The selection of these years is guided by analytical and contextual considerations. On the one hand, 2019 represents the last full year prior to the COVID-19 pandemic, capturing household expenditure patterns under pre-pandemic mobility conditions. On the other hand, 2023 reflects a post-pandemic scenario, shaped by a new policy and behavioural landscape in which sustainable transport modes, including cycling, have gained renewed prominence. Comparing these two years allows us to explore structural changes in expenditure behaviour potentially driven by the long-term effects of the pandemic on urban mobility and health-oriented consumption.

Additionally, this choice avoids the inclusion of transitory distortions in household consumption data that may have occurred during the peak pandemic years (2020-2021), which were

marked by exceptional restrictions on mobility and disruptions in retail markets. The exclusion of 2020 and 2021 is further justified by the methodological note provided by the INE, which indicates significant irregularities in consumption data during lockdown periods (INE, 2021). Moreover, studies using the EPF show that the 2020 lockdown produced heterogeneous and unexpected shifts in expenditure distribution and household savings behaviour (Jiménez-Martín et al., 2024), and analyses of the pandemic's impact on consumption underscore that the weakening of demand was particularly pronounced for durable goods and did not fully revert in 2021 (Banco de España, 2025). Finally, labour-market and consumption linkage studies reveal that the reestablishment of the pre-pandemic patterns of consumption was still incomplete in 2021 (Alvargonzález et al., 2022). Focusing on 2019 and 2023 thus ensures a more stable and representative comparison, while also enhancing the clarity of the empirical strategy without introducing excessive temporal variability into the model.

To analyse and identify the determinants of household expenditure on bicycles in Spain, total household expenditure is used as a proxy for household income, following established practice in consumption studies where self-reported income data may be unreliable or incomplete (Deaton, 2019). This proxy enables the estimation of income elasticity of demand, a key objective of the analysis.

A set of control variables captures relevant sociodemographic and geographic factors influencing bicycle-related spending. Regional variables include all Spanish autonomous communities and municipality size, categorised into four groups based on population (<20,000; 20,000–50,000; 50,000–100,000; >100,000 residents). Autonomous communities are treated individually to capture region-specific differences in infrastructure, urban planning, and environmental awareness, while the municipality size grouping balances granularity with adequate sample sizes, ensuring robust spatial analysis. These controls account for heterogeneity in cycling infrastructure, policy promotion, and environmental conditions across regions, which can affect household cycling behaviour and expenditure (Handy et al., 2014; Pucher & Buehler, 2008).

Household type reflects differences in consumption preferences and priorities, distinguishing between single-person households and those with children, for example. Larger or more complex households may have distinct transport and leisure needs, potentially increasing the likelihood of bicycle ownership or use. Similarly, the number of household members helps capture economies of scale or complementary consumption patterns within families (Attanasio & Weber, 2010).

Age is included to control for life-cycle effects, as consumption and engagement in physical or recreational activities vary across age groups (Wagner & Hanna, 1983). Younger individuals may be more likely to use bicycles for commuting or sport, whereas older individuals may exhibit lower demand or different motivations.

Gender and marital status are standard demographic variables capturing behavioural and social differences in consumption. Prior research has identified gender differences in sports consumption and transport preferences, which can influence spending on bicycles (Thibaut et al., 2016; Götschi et al., 2015).

Also, educational attainment serves as a proxy for human capital and is positively correlated with health awareness, environmental consciousness, and participation in sustainable transport

modes (Scheerder et al., 2011). Higher education levels tend to be associated with a greater valuation of cycling as a healthy and eco-friendly activity (Pucher & Buehler, 2010) as well as stronger pro-environmental attitudes (Diamantopoulos et al., 2003).

Finally, employment status of the household head reflects both economic capacity and time availability, two key components in the household production of leisure and mobility. Following Becker's (1965) model, those with more stable or flexible employment may have more time and resources to allocate to cycling-related activities and purchases. Employment status also influences travel behaviour and leisure time allocation, affecting transport mode choices and expenditure patterns (Gatersleben & Uzzell, 2007; Sener et al., 2009).

All expenditure variables have been standardised to ensure consistency across the spatial and temporal units of the household budget survey used. The combination of these variables provides a rich framework for capturing the multifaceted nature of household decision-making and identifying the key factors driving bicycle-related expenditure in Spanish households.

4. Methodology

This study adopts a two-part modelling approach to empirically examine the determinants of household expenditure on bicycles in Spain and to estimate its responsiveness to income. The choice of this methodological framework is motivated by the nature of the dependent variable (annual household expenditure on bicycles) which exhibits a large proportion of zero observations. These zero values correspond to households that did not report any bicycle-related spending during the reference period, either because they did not purchase a bicycle or because such purchases occurred outside the one-year time frame considered by the survey.

Given this distributional feature, conventional linear models such as Ordinary Least Squares (OLS) are inadequate, as they do not account for the underlying decision process that leads to zero expenditure. Applying such models in this context would likely result in biased and inconsistent parameter estimates. As noted by Mullahy (1998), separating the participation and consumption decisions provides consistent and interpretable estimates in health and consumption econometrics. To address this issue, the analysis employs a two-part model, which separately captures the extensive and intensive margins of household behaviour regarding bicycle consumption. The two-part model applied here is particularly suited for data with a large mass at zero, a common feature in consumption studies involving durable goods (Duan et al., 1983).

In the first stage, the model estimates the probability that a household incurs any expenditure on bicycles using a probit specification. This captures the extensive margin, reflecting the binary decision of whether or not to spend. In the second stage, the model estimates the level of expenditure conditional on positive spending, using a log-log specification applied to the sub-sample of households that reported non-zero expenditure. This functional form is particularly suitable for estimating income elasticity, as the coefficient on total household expenditure (used as a proxy for permanent income) can be directly interpreted as an elasticity. Specifically, it reflects the percentage change in bicycle-related spending associated with a 1% change in household income.

The value of this elasticity coefficient is central to understanding the consumption

characteristics of bicycles. An elasticity greater than one indicates that bicycles are treated as luxury goods, implying that expenditure increases more than proportionally with income. An elasticity between zero and one suggests that bicycles are considered necessity goods, with expenditure rising less than proportionally. While theoretically possible, a negative elasticity, indicating that bicycles are inferior goods, is unlikely, given the generally positive associations of cycling with health, sustainability, and well-being.

To ensure that the estimated effect of income is not confounded by other factors, the model includes a set of control variables that capture relevant sociodemographic and geographic characteristics. These include the household's region of residence, the size of the municipality, the composition of the household, and individual attributes of the household head, such as age, gender, marital status, educational attainment, and employment status.

The empirical framework is grounded in the theory of household production (Becker, 1965), which conceptualises consumption not merely as the acquisition of market goods but as the production of utility-yielding activities using time and purchased inputs. Within this framework, bicycles are understood as both durable goods and productive inputs for the generation of leisure, physical activity, and mobility, which are outcomes that households value and seek to maximise.

The data used in this study come from the Spanish Household Budget Survey (Encuesta de Presupuestos Familiares, EPF). The survey provides rich microdata on household expenditure patterns and sociodemographic characteristics, allowing for a detailed and representative analysis. To ensure population-level representativeness, the estimations apply the sampling weights provided by the National Statistics Institute. Robust standard errors are used throughout to account for potential heteroscedasticity in the second-stage regression.

By jointly modelling the likelihood of bicycle expenditure and the conditional amount spent, and by explicitly estimating income elasticity, this methodological approach provides a comprehensive and policy-relevant perspective on household behaviour. It offers insights not only into the structure of demand for bicycles in Spain, but also into broader questions related to sustainable mobility, consumer affordability, and equity in access to low-emission transport alternatives.

5. Results and discussion

The results of the two-part model estimations are presented in Tables 1 and 2 and provide a comprehensive account of the determinants of household expenditure on bicycles in Spain for the years 2019 and 2023. The findings confirm the pivotal role of income in shaping both the likelihood of bicycle-related spending and the conditional amount spent, with income elasticity figures suggesting substantial responsiveness.

With regard to the determinants of spending decisions, Table 1 shows those derived from the two-part model estimation. As might be expected, income has a direct and significant impact on Spanish households' spending on bicycles. Specifically, total household expenditure, a proxy for permanent income, is positively and significantly associated with both the probability of spending and the amount spent. This effect is robust across both years and underlines the importance of

economic capacity in enabling bicycle-related purchases. However, beyond income, several key household characteristics play substantial roles. Firstly, age of household head is negatively associated with the probability of spending in both years. Older household heads are less likely to spend on bicycles, reflecting typical life-cycle consumption patterns and declining physical activity with age. Interestingly, in 2023, age is positively associated with the amount spent, suggesting that among those who do spend, older individuals may purchase higher-end or electric bicycles, potentially for recreational or health purposes.

Secondly, about the household composition, we can see families with children under 16 show a positive association with bicycle expenditure, though this relationship does not reach conventional statistical significance in the 2023 probit model (p value=0.576). This supports the notion that bicycles are often purchased for children's mobility or recreational use. However, the amount spent by these households tends to be lower, which may reflect more basic or child-specific bicycle purchases rather than investment in expensive models.

Thirdly, households with children aged 0-15 show a significantly higher probability of spending, though often with lower conditional amounts. This suggests bicycle acquisition in these households is common but cost-constrained. The presence of household members aged 25-34 or 35-64 is negatively associated with the amount spent, which could be due to competing financial priorities or substitution with other transport modes.

Regarding employment status, shows variable effects. Unemployed individuals are less likely to report any expenditure, which is consistent with income limitations. Retired individuals show higher spending in 2019 but significantly lower conditional spending in 2023. Homeworkers and students exhibit inconsistent results, although students in 2019 report significantly lower conditional expenditure.

Also, on the one hand, education level has limited predictive power. University-educated individuals are more likely to spend in 2019, but this relationship fades in 2023. And, on the other hand, gender and marital status are generally not statistically significant, suggesting that cycling expenditure may no longer be strongly gendered or tied to family structure, at least in the aggregate. Finally, the analysis reveals notable geographical variation. In both years, regions such as Murcia, Catalonia, and the Basque Country show higher probabilities of expenditure, which likely reflects better cycling infrastructure, more favourable policies, and more deeply rooted cycling cultures.
The region of Navarre shows strong participation effects in 2019, which dissipate in 2023. In contrast, Madrid and Valencia show an increase in participation and conditional spending in 2023, possibly reflecting recent investments in urban cycling networks.

The significant negative coefficient for La Rioja in 2023 (conditional spending) may reflect unique regional dynamics, potentially including a combination of sample size limitations that amplify statistical volatility alongside structural factors such as distinctive local market conditions or particularly pronounced population ageing trends in the region.

In contrast, the size of the municipality does not appear to be a significant factor. This suggests that regional policies and infrastructure provision may be more important than mere urban density or population scale.

Table 1. Two-part model estimation: log-log model.

	2019				2023			
	Probit		Reg. MCO		Probit		Reg. MCO	
	Coef.	P>|z|	Coef.	P>|z|	Coef.	P>|z|	Coef.	P>|z|
C	-5.13	0.000	-0.196	0.874	-6.692	0.000	-3.746	0.010
Tot Expenditure	0.374	0.000	0.654	0.000	0.491	0.000	0.875	0.000
Region								
Andalucía	0.248	0.009	-0.962	0.003	0.447	0.001	-0.033	0.925
Aragón	0.019	0.870	-0.072	0.836	0.248	0.096	-0.636	0.114
Asturias	-0.019	0.882	0.412	0.174	0.344	0.055	-0.207	0.551
Baleares	-0.126	0.340	0.467	0.160	0.190	0.265	-0.656	0.082
Canarias	0.033	0.771	0.370	0.207	0.332	0.018	0.243	0.571
Cantabria	0.052	0.592	0.041	0.859	0.236	0.093	0.086	0.825
Castilla y León	-0.062	0.581	-0.004	0.986	0.440	0.002	0.293	0.396
C.–La Mancha	-0.084	0.325	0.117	0.569	0.374	0.001	0.152	0.627
Cataluña	0.065	0.436	0.126	0.552	0.450	0.000	0.084	0.794
C. Valenciana	0.112	0.271	0.089	0.722	0.343	0.014	-0.049	0.900
Extremadura	0.029	0.769	-0.346	0.208	0.340	0.005	0.066	0.825
Galicia	-0.107	0.268	0.221	0.312	0.075	0.542	-0.070	0.830
Madrid	0.069	0.548	-0.236	0.256	0.369	0.005	0.278	0.416
Murcia	0.263	0.013	-0.162	0.577	0.657	0.000	-0.438	0.226
Navarra	0.201	0.009	-0.608	0.011	0.485	0.000	0.021	0.944
País Vasco	0.114	0.345	-0.085	0.759	0.602	0.000	0.132	0.707
Rioja, La	-0.191	0.522	0.162	0.602	-0.294	0.475	-4.175	0.000
Ceuta	0.902	0.002	-0.062	0.918	0.321	0.247	-1.064	0.133
Residents								
10m<res<20m	-0.039	0.624	0.192	0.349	-0.029	0.767	-0.388	0.103
20m<res<50m	-0.055	0.437	-0.013	0.946	0.485	0.542	0.019	0.928
50m<res<100m	-0.120	0.136	0.065	0.733	-0.002	0.985	-0.090	0.674
>100m res	-0.090	0.141	-0.061	0.698	-0.039	0.605	-0.019	0.922
Families								
Couple without children	0.128	0.241	0.139	0.621	-0.094	0.439	0.075	0.795
Couple with children < 16 years old	0.328	0.004	-0.380	0.137	0.780	0.576	-0.476	0.078
Other family nuclei	0.269	0.048	-0.123	0.718	-0.144	0.329	-0.367	0.294
Other households	0.414	0.008	-0.073	0.851	-0.098	0.636	-0.157	0.708
Age	-0.013	0.000	-0.011	0.203	-0.014	0.000	0.027	0.005
No. family members by age group								
0 - 4	0.223	0.000	-0.423	0.000	0.123	0.057	-0.331	0.013
5 - 15	0.161	0.000	-0.118	0.200	0.169	0.000	-0.201	0.013
16 - 24	-0.133	0.026	0.118	0.438	-0.024	0.678	-0.106	0.476
25 - 34	-0.080	0.216	-0.278	0.117	0.052	0.530	-0.323	0.002
35 - 64	-0.025	0.705	-0.347	0.054	0.087	0.263	-0.195	0.190
65 – 84	-0.055	0.471	-0.657	0.020	0.004	0.973	-0.269	0.226
85 or more	-0.301	0.040	1.085	0.007	-0.212	0.221	0.196	0.424
Gender								
Female	-0.076	0.143	0.039	0.743	-0.062	0.298	-0.187	0.164
Marital status								
Couple	-0.042	0.494	0.122	0.415	-0.076	0.284	-0.070	0.698
Educational level								
Intermediate studies	0.103	0.050	0.054	0.721	-0.093	0.190	0.221	0.223
University	0.133	0.025	0.110	0.489	-0.056	0.470	0.162	0.366
Employment status								
Unemployed	-0.204	0.067	-0.308	0.188	0.079	0.599	-0.146	0.554
Retired	-0.055	0.577	0.556	0.074	-0.005	0.968	-0.773	0.052
Student	0.114	0.808	-1.671	0.000	N/A	N/A	N/A	N/A
Homeworker	-0.725	0.001	-1.231	0.200	-0.390	0.189	0.276	0.520
Inactive	-0.135	0.558	0.880	0.000	-0.179	0.364	0.744	0.001

Note. N/A: Insufficient data for a reliable estimate.

Table 2 shows the income elasticity values derived from the estimate for Spanish households' expenditure on bicycles. Concretely, the income elasticity of bicycle expenditure, decomposed into participation elasticity (extensive margin), conditional elasticity (intensive margin), and total elasticity. The results show a clear shift in the nature of bicycle consumption between 2019 and 2023.

Table 2. Results of the estimation of bicycle expenditure models: elasticities.

Mod. Probit + Log-Log	Elast. Partic.	Elast. Cond.	Elast. total
2019	0.9039	0.6541	1.5580
2023	1.2709	0.8752	2.1461

The income elasticity estimates derived from the two-part model offer meaningful insight into the nature of household expenditure on sport-oriented bicycles in Spain. In both 2019 and 2023, total income elasticity exceeds one (rising from 1.56 to 2.15) indicating that this category of expenditure is treated as a luxury good in economic terms. This result stems from increased responsiveness at both the extensive margin (probability of expenditure) and the intensive margin (level of spending among those who purchase).

The growing elasticity suggests that, over time, bicycles have become more prominent in household budgets as discretionary recreational goods, potentially reflecting shifts in lifestyle preferences, growing health awareness, or post-pandemic changes in leisure consumption. However, the strong income dependence also raises distributional concerns. If higher bicycle expenditure is increasingly concentrated among higher-income households, this could reinforce inequalities in access to the physical, social, and environmental benefits associated with cycling.

The increase in participation elasticity (from 0.90 to 1.27) suggests that the decision to initiate bicycle expenditure has become substantially more income-sensitive than the decision regarding how much to spend. This phenomenon could be explained by the post-pandemic 'normalization' of cycling as a mainstream recreational activity among higher-income groups, for whom initial adoption represents a discretionary lifestyle choice. Concurrently, lower-income households may face persistent financial barriers to market entry, even for basic models, while those who do participate show more stable spending patterns relative to their income.

The high-income elasticity estimates must be interpreted within the context of our 'sports bicycle' focus. It is plausible that expenditure on purely utilitarian bicycles would exhibit lower income sensitivity, as these represent essential transport goods for daily mobility rather than discretionary recreational purchases. This distinction suggests that policy interventions may need differentiation: while redistributive fiscal measures could address affordability across both segments, promotional campaigns might need tailoring, emphasizing practical utility for lower-income groups versus recreational benefits for higher-income adopters.

6. Conclusions

This study has examined the determinants of household expenditure on sport bicycles in Spain, using a two-part model applied to microdata from the Spanish Household Budget Survey for the years 2019 and 2023. The analysis focused on capturing both the decision to engage in bicycle-related spending and the amount spent, providing insights into the sociodemographic, geographic, and economic variables that influence cycling-related consumption. Importantly, the findings have direct implications for the design of public policies aimed at fostering sustainable and inclusive mobility.

As a main result, we can indicate that income consistently plays a significant role in explaining household spending on sports bicycles. Both the probability of spending and the conditional amount spent rise with income, and this effect has strengthened over time. The estimated income elasticities suggest that sport bicycles are increasingly treated as luxury goods. This pattern indicates that, while income growth can stimulate demand for cycling-related goods, it also contributes to widening disparities in access to bicycles, particularly for low-income households. In this context, public policy must not assume that promoting cycling infrastructure alone will ensure equitable adoption. As Banister (2008) points out, infrastructure provision is necessary but insufficient: effective transport equity requires complementary interventions that target behavioural, cultural, and financial barriers.

Moreover, the growing income dependence of bicycle expenditure raises distributional concerns. If cycling becomes increasingly income-sensitive, as the elasticity results suggest, public authorities risk reinforcing socio-economic inequalities in access to active mobility options (Lucas, 2012). To counter this trend, a comprehensive policy approach should integrate three complementary strands of intervention. First, fiscal measures must directly address affordability barriers through means-tested purchase subsidies, VAT reductions on non-motorised bicycles, and support for affordable second-hand markets. Second, infrastructural policies need to ensure equitable access by developing safe, age-friendly cycling networks (including dedicated routes for schools and families) and promoting coherent regional implementation to address spatial disparities. Third, educational and behavioural initiatives are essential to foster cultural change through public awareness campaigns, cycling education programmes in schools, and participatory planning to overcome safety concerns and social norms.

This integrated strategy finds further application when considering specific demographic patterns. Household structure and composition substantially influence expenditure decisions, as families with children under the age of 16 are more likely to spend on bicycles, albeit often at lower price points. Public policy should respond by combining the three policy pillars: supporting family-oriented cycling through infrastructure adapted for children, such as school cycling lanes; implementing fiscal measures like discounts for multi-bicycle purchases; and developing educational programmes that combine mobility and education objectives. Similarly, the negative association between age and the likelihood of spending highlights the relevance of life-cycle effects. To promote lifelong cycling, strategies for older populations should include investment in age-friendly infrastructure, public rental schemes with adapted models, and educational partnerships with the health sector that encourage recreational cycling as part of active ageing policies.

The analysis also identifies significant regional disparities in expenditure behaviour, which

likely reflect uneven implementation of cycling policies, differences in urban planning, and cultural variations in transport preferences. Regions such as Cataluña, the País Vasco, and Murcia show consistently higher levels of bicycle-related expenditure, suggesting that coherent cycling policies can positively influence household consumption. These findings underscore the need for decentralised and place-based policy approaches that combine the three pillars within regional contexts. While the Spanish national cycling strategy provides a common framework, its effectiveness depends on strong implementation at regional and municipal levels through coordinated fiscal incentives, targeted infrastructural investments, and context-specific educational programmes.

A final consideration concerns the scope of our analysis, which focuses specifically on conventional bicycles. While the exclusion of e-bikes may omit part of the recent market expansion, it allows a clearer focus on conventional bicycles, which are most closely associated with active mobility and direct physical activity benefits. As statistical classifications evolve to better distinguish electric and non-electric bicycles, future research could revisit the analysis to capture the changing composition of cycling expenditure.

This integrated strategy, combining financial support, inclusive infrastructure, and targeted communication, is crucial to prevent cycling from becoming stratified along socioeconomic lines (Gössling & Choi, 2015) and to align Spain's mobility transition with principles of equity and environmental justice. Household bicycle expenditure is not merely a function of preferences or income, but is shaped by a complex interplay of structural, territorial, and policy factors. If cycling is to play a meaningful role in Spain's sustainable mobility transition, public policy must move beyond isolated interventions and embrace a holistic approach that simultaneously addresses affordability, accessibility, and social acceptance across all demographic groups and territories.

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