

Research article

Reevaluating tobacco taxes in Spain: Revenue maximization, equity, and public health in an aging society

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Abstract: In this study, we examined the role of tobacco taxation in Spain, focusing on its effectiveness in reducing smoking, generating fiscal revenue, and promoting health equity within the framework of health economics and national accounting. Using panel data econometrics across Spain's 48 provinces from recent decades, we evaluated the relationship between tax rates, tobacco consumption, and fiscal outcomes. Our results suggested that while tobacco taxes are effective in reducing consumption overall, their impact is limited by tax disparities between products and substitution toward roll-your-own (RYO) tobacco. Furthermore, demographic factors, including aging populations and socio-economic disparities, significantly influenced consumption patterns and tax sensitivity. Evidence indicated that Spain's current tobacco tax rates might fall below the revenue-maximizing point, leading to potential fiscal losses. Accounting for these findings, we highlighted pathways to refine the tax structure, including integrating specific and ad valorem taxes, adjusting for inflation, and harmonizing rates across tobacco products. These insights contribute to the optimization of tobacco taxation, supporting fiscal sustainability and public health outcomes.

Keywords: tobacco taxation; public health economics; fiscal policy and revenue; price elasticity and consumption; demographics and aging populations

JEL Codes: H25, I18, H21, D12, J14

1. Introduction

Understanding the effects of tobacco taxation is crucial for designing policies that effectively reduce smoking, enhance public health, and optimize fiscal revenue. Although its impacts are well-documented in prior literature, they must be analyzed in specific socio-economic and demographic contexts to ensure the design of equitable and effective measures. For instance, the variations in price elasticity among different population groups, such as youth, low-income households, and heavy smokers, underline the need for tailored approaches in tax policy. Furthermore, examining substitution behaviors, such as switching to lower-cost tobacco products or informal markets, is essential to understand potential unintended consequences of tax increases. Additionally, demographic factors, including an aging population and socio-economic disparities, play a significant role in shaping consumption patterns and sensitivity to price changes.

We explore these aspects by reviewing key studies on the relationship between tobacco taxes, smoking behavior, cessation rates, and economic equity. Additionally, we examine the Laffer Curve (Laffer, 2004) to identify optimal tax rates that maximize revenue without causing excessive declines in demand, drawing insights from international evidence. In the context of Spain, we investigate recent trends in substitution effects, affordability, and the performance of current tobacco tax policies. Through the analysis of provincial panel data and econometric methods, this paper provides evidence-based insights into the structure of tobacco taxation in Spain, offering guidance for potential reforms to strengthen health and fiscal sustainability.

1.1. Impact of tobacco taxation on public health, economic outcomes, and equity

Research consistently demonstrates that tobacco taxation is an effective mechanism for reducing consumption while enhancing public health, generating fiscal revenue, and promoting economic equity (Chaloupka, 1999; Reed et al., 2008; Bader et al., 2011; Nazar et al., 2021; Zeduri et al., 2023). Geboers et al. (2023) identified the cost of tobacco as one of the most reported reasons for quitting smoking. Several empirical studies have measured the adverse impact of tax-induced price increases on smoking prevalence (Lance et al., 2004; Kostova et al., 2015; Dauchy and Ross, 2019; Matsubayashi et al., 2021; Immurana et al., 2021; Huque et al., 2023; Zeduri et al., 2023). Moreover, other researchers have focused on breaking down the findings by population groups, highlighting that different segments of the population tend to react differently (Bader et al., 2011; Hiscock et al., 2012; Nazar et al., 2021).

A notable population group where pricing plays a pivotal role is youth, as higher tobacco prices are particularly effective in preventing the initiation of smoking within this demographic group. Numerous researchers have consistently found significant effects on young people, especially on reducing smoking initiation. Chaloupka et al. (2012, 2011) conclude that increased tobacco taxes reduce smoking rates, especially among youth, by encouraging cessation and discouraging uptake, with these effects evident across demographic segments. Similarly, Friedson et al. (2023) highlighted the long-term health benefits of high tobacco taxes during adolescence, noting reductions in adult smoking and lower mortality rates from diseases such as lung cancer and heart disease. The 2012 U.S. Surgeon General's report on youth prevention and the 2014 report commemorating fifty years of

progress further underscore the essential role of price increases in curbing tobacco use and preventing initiation among young people. Consistent with these findings, the World Health Organization's (WHO) MPOWER framework (2008) identifies pricing policies as a cornerstone for preventing youth smoking and bolstering global tobacco control initiatives.

However, taxes on tobacco may not always be effective in deterring people from consuming tobacco, since some consumers may opt for cheaper brands to minimize costs (Geboers et al., 2023; White et al., 2005; Choi et al., 2011) and others may switch to other forms of tobacco product. Researchers focusing on alternative tobacco products analyze the effect on different substitution products, such as roll-your-own (RYO) cigarettes or e-cigarettes (Abouk et al., 2023; Cotti et al., 2022). Several studies have shown that such price-minimizing strategies are quite common. These measures are more common among subgroups that are more sensitive to price (Geboers et al., 2023) and among low socio-economic status (SES) smokers (Hiscock et al., 2012). In the case of e-cigarettes, while e-cigarette taxes reduce their usage, they may inadvertently increase traditional cigarette consumption due to substitution effects (Abouk et al., 2023; Cotti et al., 2022). In this way, taxes produce a substitution effect that, far from causing a drop in consumption, increases the use of other alternative forms of smoking. Minimizing price disparities between products is crucial to prevent price-avoidance behaviors (White et al., 2005; Geboers et al., 2023). Failing to address these differences may lead smokers to act contrary to the negative price elasticity of demand for tobacco products consistently demonstrated in empirical studies (Fernández et al., 2015; Martín-Álvarez et al., 2020; Huque et al., 2023).

The economic impacts of tobacco taxation are well-documented. Gospodinov and Irvine (2009) and Divino et al. (2022) found that although tobacco taxes may initially impose a heavier burden on low-income consumers, the associated health improvements often mitigate these costs over time. This underscores the importance of accounting for socio-economic disparities when designing and evaluating tobacco control policies. Additionally, lower-income populations are more likely to engage in price-minimizing behaviors, such as switching to cheaper brands or buying tobacco in bulk, in response to price increases. In Brazil, Divino et al. (2022) reported that higher taxes reduce tobacco spending and improve well-being, particularly for low-income households. Pichon-Riviere et al. (2024) estimated that comprehensive tobacco control measures, including tax hikes in Latin America, could prevent 271,000 deaths over the next decade while generating economic benefits of up to \$63.8 billion. Similarly, Saenz de Miera et al. (2022) demonstrated that a one-peso tax increase in Mexico could prevent 630,000 premature deaths, with significant benefits for lower-income populations.

In the Netherlands, Van Baal et al. (2007) observed that although increased life expectancy due to smoking cessation may lead to higher healthcare costs, these are offset by additional tax revenues, confirming tobacco taxation as a cost-effective policy. Moreover, Nargis et al. (2020) and Lee et al. (2024) confirmed that well-designed tobacco taxes can increase fiscal revenue even with declining consumption, delivering substantial benefits, particularly in low- and middle-income countries.

In summary, evidence underscores the effectiveness of tobacco taxation as a key instrument for reducing chronic diseases, advancing equity, and ensuring sustainable revenue generation, with particularly pronounced health and economic advantages for low-income regions.

1.2. The relationship between tobacco taxes and the Laffer Curve

The Laffer Curve is an economic framework illustrating the relationship between tax rates and fiscal revenue, identifying an optimal tax rate that maximizes revenue. This concept is especially pertinent to tobacco taxation, where setting taxes too low results in insufficient revenue, while excessively high rates may reduce demand to the point of diminishing returns or encourage smuggling.

Several researchers have applied this framework to tobacco taxation. For instance, Olesinski et al. (2020) analyzed the elasticity of tobacco demand in Poland using a state-space model. Their findings suggest that a balanced tax structure combining specific and ad valorem taxes helps policymakers achieve an optimal position on the “Laffer surface,” maximizing revenue without excessively reducing demand. This underscores the importance of maintaining a balanced tax structure instead of increasing one type of tax disproportionately, to optimize revenue while minimizing efficiency losses.

Similarly, Norashidah et al. (2013) applied the Laffer Curve to determine the “optimal tax” on tobacco in Malaysia. By analyzing demand elasticity and projections, they estimate that a tax rate 16.5% higher than the current level could increase revenue by 23.6% in the long term. This indicates that in many countries, current tax rates are below the revenue-maximizing point, suggesting that moderate increases could improve fiscal outcomes while curbing consumption.

Arslanhan et al. (2012) examined the case of Turkey, finding that an increase in the specific tax on tobacco would generate net fiscal benefits up to the Laffer Curve's optimal point. While cessation programs may offer societal welfare benefits, they argue that tax increases provide an additional fiscal advantage, allowing the public sector to capture more revenue before hitting the revenue-reducing threshold.

Studies by Pichon-Riviere et al. (2024) and Saenz de Miera et al. (2022) further affirmed the existence of a fiscal optimum on the Laffer Curve. Their work highlights that in Latin America and Mexico, better-designed tax structures could increase fiscal revenue while simultaneously reducing tobacco prevalence. These findings suggest that tobacco taxes in these regions remain on the upward-sloping side of the curve, enabling both revenue growth and reductions in healthcare costs associated with tobacco-related illnesses.

Recent contributions offer additional perspectives that reinforce and expand the findings reported in this paper. Friedson et al. (2023) showed that exposure to higher cigarette taxes during adolescence significantly reduces smoking participation and mortality in adulthood, particularly from heart disease and lung cancer. Hansen et al. (2013) explored the mechanisms through which youth access cigarettes, finding that higher taxes reduce smoking by disrupting secondary acquisition channels.

Lovenheim (2008) examined the prevalence and impact of casual cross-border cigarette smuggling in the United States, underscoring the importance of tax harmonization to prevent revenue loss. Similarly, Harding et al. (2012) demonstrated that the incidence of cigarette taxes varies widely across geographic and socioeconomic groups, suggesting that tax policy must consider heterogeneity in consumer responses.

Finally, DeCicca et al. (2022) provided a comprehensive review of the economics of tobacco regulation, integrating taxation with complementary tools such as advertising bans and cessation support. Their work reinforces the need for a multidimensional approach to tobacco control.

In conclusion, the interplay between the Laffer Curve and tobacco taxation demonstrates that governments can enhance fiscal revenue and lower tobacco consumption by targeting the curve's

optimal point. This optimal rate varies by country and depends on demand elasticity, tax structure (specific versus ad valorem), and contextual factors, necessitating tailored analyses for effective policy implementation.

1.3. Challenges and prospects for tobacco taxation as a public health tool in Spain

Research on tobacco taxation in Spain highlights the intricate relationship between fiscal policies and tobacco consumption, particularly in the context of product heterogeneity, substitution dynamics, and the socio-economic implications of taxation. In 2005, Spain became a party to the WHO Framework Convention for Tobacco Control (FCTC), a global treaty aimed at reducing tobacco use and exposure. This commitment has shaped Spain's regulatory environment, introducing international standards for restricting advertising, reducing tobacco consumption, and promoting public health. These measures provide an essential backdrop for understanding the broader impact of fiscal policies and their interplay with national efforts to control tobacco use.

The effectiveness of tobacco taxation is often constrained by substitution effects, as seen in Spain. Burguillo et al. (2019) analyzed how tax increases on manufactured cigarettes often lead consumers to switch to cheaper alternatives, such as RYO tobacco, undermining the overall reduction in consumption. Using a pseudo-panel model, the study finds that cigarettes and RYO are substitute goods, explaining the growth in RYO consumption as cigarette prices rise. Fu et al. (2014) further documented this trend, noting a 14% annual increase in RYO consumption between 1991 and 2012 as manufactured cigarette consumption declined, driven largely by the tax gap between these products.

The influence of European Union (EU) tax legislation also plays a significant role. López-Nicolás et al. (2013) assessed the implementation of a minimum tax on cigarettes in Spain, finding that while it increased prices, its impact on reducing smoking prevalence was limited, particularly among men, due to the availability of cheaper RYO tobacco. This fiscal leakage underscores the necessity of harmonizing tax rates across products to close gaps that encourage consumers to seek affordable alternatives.

Recent evidence highlights the stagnation of Spain's tobacco taxation policies. López-Nicolás et al. (2024) reported that Spain's Tobaccconomics tax score dropped from 3.9 in 2014 to 2.625 in 2020 due to the absence of tax adjustments amid rising inflation and incomes. This stagnation has increased the affordability of tobacco products by 13%, while the price gap between manufactured cigarettes and RYO remains at €2, reducing the deterrent effect of taxation. Additionally, the growing price differential with neighboring France exacerbates cross-border purchases. Simulations suggest that eliminating the price gap between FM and RYO could prevent 700,000 smokers, avert 210,000 premature deaths, and significantly increase fiscal revenue by 2028. They conclude that urgent reforms are necessary, suggesting that Spain's Minimum Excise Tax should be increased to address the affordability of tobacco and improve public health and revenue outcomes.

Socio-economic disparities further influence the effectiveness of tobacco taxes in Spain. Regidor et al. (2001) and Nieto González et al. (2023) identified a socio-economic gradient in smoking prevalence, with higher rates among lower-income and less-educated groups. Between 1987 and 1997, smoking prevalence declined among men but increased among women in lower social classes, suggesting varying sensitivities to tax measures across demographics. Moreover, Pinilla (2002) noted that Spain's reliance on ad valorem taxes has enabled tobacco companies to maintain the availability of inexpensive products, reducing the effectiveness of tax increases. Shifting towards specific taxes,

combined with regular adjustments for inflation, could better address these disparities and more effectively limit access to low-cost tobacco.

The potential of fiscal policy reforms to strengthen public health is evident. Pérez-Ríos et al. (2024) advocated for applying taxes equitably across all tobacco products to minimize substitution effects and recommend regular adjustments for inflation and income growth. These measures would enhance the sustainability and long-term effectiveness of tobacco taxation in reducing consumption.

Overall, these studies show that while tobacco taxes in Spain have been useful for raising prices and moderating consumption, their total impact has been limited by tax disparities between products, access to lower-cost alternatives, and variations in price sensitivity across socio-economic groups. The findings by López-Nicolás et al. (2024) suggested that Spain's failure to adjust minimum taxes to match inflation and income growth has made tobacco products increasingly affordable, exacerbating the need for reform. A tax policy that integrates both specific taxes and regular adjustments, while eliminating disparities between tobacco products, is essential to achieve sustainable reductions in tobacco consumption and its public health consequences.

To the best of our knowledge, while substantial research has explored the impacts of tobacco taxation in Spain, the applicability of the Laffer Curve to different tobacco products remains underexplored. We address that gap by leveraging panel data from 48 Spanish provinces, analyzed using panel econometric techniques, to assess whether current tax levels optimize revenue for various tobacco categories. This analysis is particularly relevant, as Figure 1 suggests that in some provinces, cigarette taxation may be on the downward-sloping side of the Laffer Curve, indicating potential revenue losses.

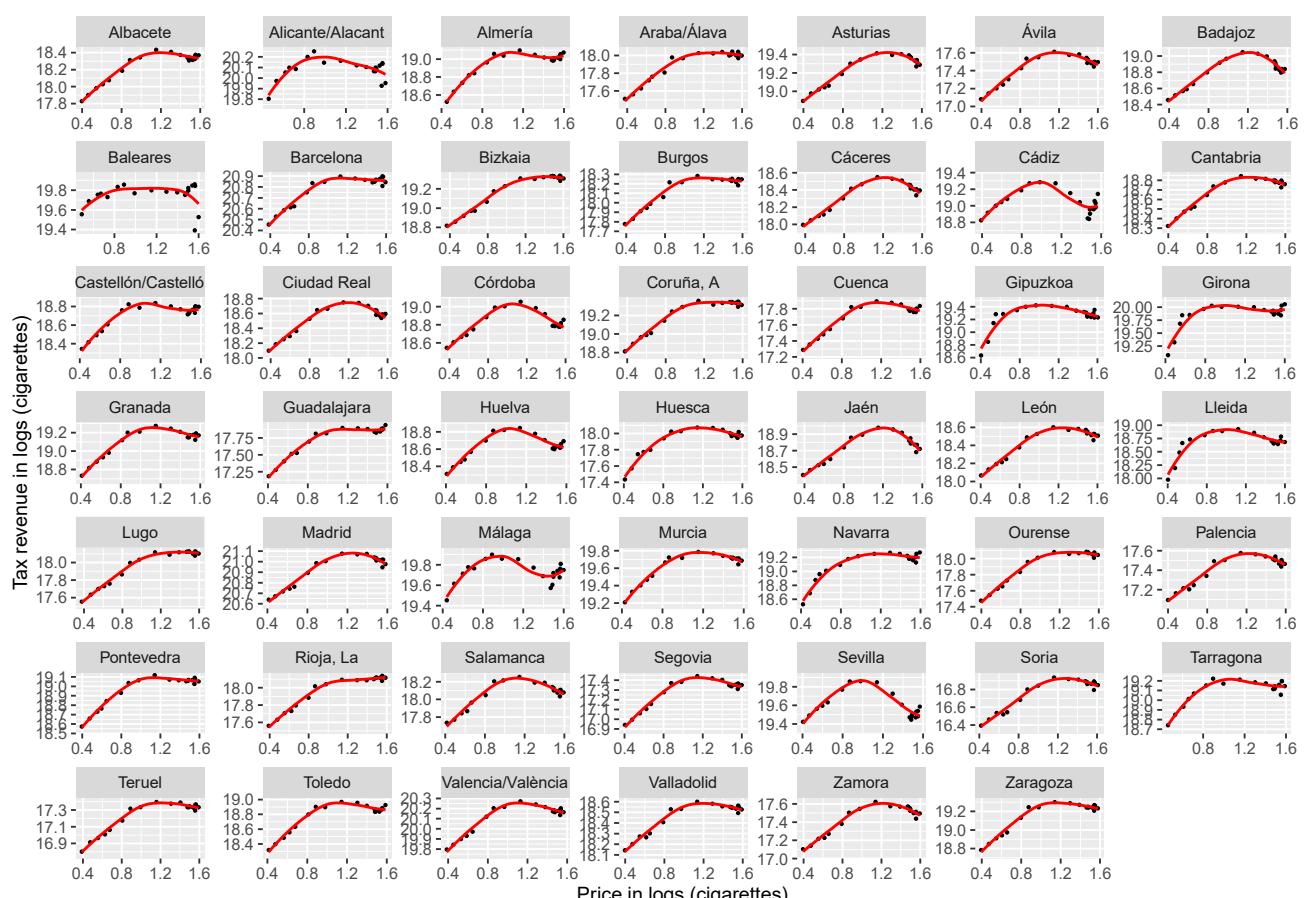


Figure 1. Relationship between cigarettes prices and tax revenue by province in Spain.

Although tobacco taxes in Spain have successfully raised prices and moderated consumption, their overall impact has been constrained by tax disparities, substitution effects, and socio-economic inequalities. Without inflation-adjusted increases, tobacco affordability has risen, diminishing the deterrent effects of current policies. A comprehensive approach that integrates specific taxes, harmonizes rates across products, and adjusts for inflation is essential to achieving sustainable reductions in tobacco use and its public health consequences.

By evaluating Spain's tobacco tax structure in relation to the revenue-maximizing point of the Laffer Curve, this study provides valuable insights into the fiscal and public health benefits that could result from adjusting tax rates across different tobacco products.

2. Materials and methods

In this section, we detail the data utilized and describe the econometric approach adopted to evaluate whether Spain's tobacco tax structure aligns with the revenue-maximizing point on the Laffer Curve.

2.1. Data

Data on tobacco product sales are sourced from Spain's Ministry of Finance and Public Administration, while socioeconomic explanatory variables are obtained from the National Institute of Statistics of Spain. The datasets span the 48 Spanish provinces where tobacco was legally sold in the regulated market between 2002 and 2021, yielding a total of 960 observations per variable. For consistency in analysis, the data are transformed into logarithmic form, enabling coefficient interpretation as elasticities and mitigating the influence of outliers. However, this transformation has limitations, such as excluding observations with zero values and potentially underrepresenting variability in variables with skewed or limited distributions. Descriptive statistics for the variables used in the analysis are presented in Table 1.

Table 1. Descriptive Statistics of tax revenue, price and socioeconomic variables (in logs).

Variable	Mean	Max	Min	SD	Q1	Q2	Q3
Tax revenue (cigarettes)	18.70	21.10	16.40	0.92	18.00	18.70	19.30
Tax revenue (cigars)	15.60	17.90	13.90	0.84	15.00	15.60	16.30
Tax revenue (RYO)	15.10	18.90	10.20	2.00	13.70	15.50	16.60
Tax revenue (pipe)	12.50	17.80	8.59	1.84	11.10	12.60	13.90
Price (cigarettes)	1.15	1.61	0.37	0.42	0.76	1.35	1.51
Price (cigars)	-1.32	1.26	-1.85	0.33	-1.56	-1.34	-1.15
Price (RYO)	4.54	5.25	3.08	0.66	3.86	4.84	5.14
Price (pipe)	4.20	5.64	2.98	0.42	3.85	4.09	4.42
Life expectancy	4.41	4.44	4.35	0.02	4.39	4.41	4.42
Aging ratio	0.35	1.22	-0.33	0.34	0.09	0.30	0.60
Youth ratio	-1.58	-1.32	-1.95	0.14	-1.66	-1.55	-1.47

2.2. Methodology

To address our research questions, we employ panel data methods to analyze the relationship between sociodemographic factors and tobacco product sales across Spain's 48 provinces. Specifically, we follow model specifications from Health Economics literature on consumption patterns:

$$Tax\ revenue_{st} = \beta_1 price_{st} + \beta_2 (price_{st})^2 + X'\delta + \gamma_s + \tau_t + \varepsilon_{st} \quad (1)$$

where $Tax\ revenue_{st}$ denotes the tax revenue in province s at time t , β_1 and β_2 capture the effects of price and its square, X' represents a vector of time-varying socioeconomic factors, γ_s denotes province-specific fixed effects, τ_t represents year fixed effects, and ε_{st} is the error term. This model enables us to evaluate the price-related impact on $taxrevenue$, testing for the inverted U-shaped relationship suggested by the Laffer Curve.

The econometric analysis includes several robustness checks. We first assess whether the time series data are stationary, as non-stationarity could result in spurious regressions unless cointegration is present. We conduct the Cross-sectional Im-Pesaran-Shin (CIPS) test for stationarity (Pesaran, 2007):

$$y_{it} = \rho_i y_{it-1} + \sum_{j=1}^p \phi_{ij} \Delta y_{it-j} + \varepsilon_{it} \quad (2)$$

where y_{it} represents the variable for entity i at time t , ρ_i is the autoregressive coefficient, ϕ_{ij} are lagged differences, and ε_{it} is the error term. The CIPS statistic averages the cross-sectional Augmented Dickey-Fuller (ADF) statistics, represented by:

$$CIPS = \frac{1}{N} \sum_{i=1}^N CADF_i \quad (3)$$

where $CADF_i$ is the cross-sectional ADF statistic for each entity i :

$$CADF_i = \frac{y_{it} - \bar{y}_t}{\sigma_y} \quad (4)$$

If the CIPS statistic falls below a critical value, it indicates stationarity in at least one panel. If the CIPS test shows that not all series are stationary, which is necessary to avoid spurious regressions, the next step is to test for cointegration relationships among the variables. To assess the existence of a long-run equilibrium relationship between the variables in our panel data, we employ the Pedroni (1999, 2004) panel cointegration test. This step ensures that, even with non-stationary variables, meaningful relationships can be analyzed in the long run.

Following stationarity and cointegration testing, we determine the appropriate model for our panel data using the Hausman test (Hausman, 1978), which assesses whether a Fixed Effects (FE) or Random Effects (RE) model is more suitable. The acceptance of the null hypothesis in the Hausman test validate the Random Effects model as appropriate the appropriate one (i.e., the random effects are uncorrelated with the regressors). Contrary, the alternative Hypothesis indicates that the Fixed Effects model is preferable (i.e., the random effects are correlated with the regressors). The Hausman test compares the consistency of the FE and RE estimators by evaluating whether unique errors correlate with the regressors:

$$H = (\hat{\beta}_{RE} - \hat{\beta}_{FE})' [Var(\hat{\beta}_{FE}) - Var(\hat{\beta}_{RE})] - 1(\hat{\beta}_{RE} - \hat{\beta}_{FE}) \quad (5)$$

A significant H statistic suggests that the FE model is preferable, indicating correlation between the random effects and regressors; otherwise, the RE model is appropriate.

Finally, we apply the specified panel data model to examine the relationship between price and tax revenue across products (cigarettes, RYO, pipe, cigars), testing the Laffer hypothesis of an inverted U-shape and examining the potential influence of socioeconomic variables. These steps ensure the robustness of our findings, providing a comprehensive understanding of economic impacts on tobacco consumption patterns in Spain.

3. Results

In this section, we report the results of the Laffer Curve analysis, based on the econometric methodology described above. Tables 2 to 4 summarize the findings from each analytical stage. Table 2 presents the results of the CIPS test for unit roots, which indicates that all the time series used are non-stationary.

Table 2. CIPS test results for unit roots across the used variables.

Variable	CIPS Test Statistic	p-value	Lag order	Conclusion
Tax revenue (cigarettes)	-2.474	0.095	2	Non-stationary
Tax revenue (cigars)	-1.414	0.097	2	Non-stationary
Tax revenue (RYO)	-3.393	0.009	2	Non-stationary
Tax revenue (pipe)	-1.529	0.095	2	Non-stationary
Price (cigarettes)	-5.258	0.010	2	Non-stationary
Price (cigars)	-2.076	0.096	2	Non-stationary
Price (RYO)	-2.771	0.018	2	Non-stationary
Price (pipe)	-1.979	0.009	2	Non-stationary
Life expectancy	-2.434	0.098	2	Non-stationary
Aging ratio	-1.218	0.097	2	Non-stationary
Youth ratio	-2.487	0.096	2	Non-stationary

Table 3 provides the outcomes of the Pedroni cointegration test, which rejects the null hypothesis at various significance levels, confirming the existence of strong long-term relationships among the variables.

With stationarity and cointegration established, the analysis moves forward with a Fixed Effects (FE) estimation, detailed in Table 4, to evaluate the influence of price and demographic factors on tax revenue. The Hausman test consistently indicated that the FE model is preferable to the Random Effects (RE) model, confirming it as the appropriate specification. This choice accounts for correlations between individual effects and regressors, ensuring the robustness of our findings in analyzing the dynamics of the tobacco market.

Table 3. Pedroni's cointegration tests results.

Test	Empirical Statistic	Standardized Statistic	Bootstrap critical values			Conclusion
			10%	5%	1%	
Panel v-statistic	0.009	-1.203	-2.58	-1.96	-1.28	Reject H ₀
Panel p-statistic	167.720	26.534	-2.58	-1.96	-1.28	Reject H ₀
Panel non-parametric t-statistic	54.687	77.813	-2.58	-1.96	-1.28	Reject H ₀
Panel parametric t-statistic	27458.465	28524.802	-2.58	-1.96	-1.28	Reject H ₀
Group p-statistic	34.745	19.739	-2.58	-1.96	-1.28	Reject H ₀
Group non-parametric t-statistic	11.312	44.328	-2.58	-1.96	-1.28	Reject H ₀
Group parametric t-statistic	8.308	40.311	-2.58	-1.96	-1.28	Reject H ₀

Table 4. Results of the fixed effects model to measure the impact of price and demographic factors on tax revenue.

Independent Variables	Dependent variable (tax revenue)			
	Cigarettes	RYO	Pipe	Cigars
Price	1.756*** (0.059)	8.580*** (0.611)	-3.851*** (0.949)	0.009 (0.031)
Price ²	-0.704*** (0.002)	-0.708*** (0.069)	0.557*** (0.108)	0.144*** (0.014)
Life expectancy	0.378 (0.471)	-0.535 (2.460)	66.250*** (2.257)	8.223*** (0.409)
Aging ratio	-0.372*** (0.046)	-0.573* (0.285)	2.038*** (0.426)	0.111* (0.056)
Youth ratio	-0.022 (0.059)	-1.539*** (0.375)	-2.178*** (0.546)	-0.629*** (0.083)
Observations	960	960	960	960
R ²	0.825	0.932	0.780	0.715

Notes: ***, ** and * indicate significance at 1%, 5% and 10%, respectively.

The model evaluates the factors influencing tax revenue from tobacco products, such as cigarettes, RYO, pipe tobacco, and cigars, using a fixed-effects panel data framework.

For cigarettes and RYO, price increases initially boost tax revenue, but the negative quadratic term indicates diminishing returns, suggesting these products are approaching the revenue-maximizing point on the Laffer Curve. Beyond this point, further price increases may lead to reduced revenue as consumption declines. This highlights a narrow margin for effective price adjustments without risking revenue losses.

In the case of pipe tobacco, the negative relationship between price and revenue suggests it has already surpassed the optimal point on the Laffer Curve, where higher prices result in significant demand reductions and declining revenue. For cigars, the non-significant price effect implies that revenue remains relatively stable regardless of price changes, indicating a potential equilibrium point on the Laffer Curve.

Demographic factors also influence tax revenues. Higher life expectancy is positively associated with revenues from pipe tobacco and cigars, while a larger proportion of elderly individuals decreases revenue from cigarettes and RYO but increases it for pipe tobacco and cigars. Conversely, a higher youth ratio correlates with lower revenues across all tobacco categories except cigarettes.

These results emphasize the need for tailored tax policies that account for the specific demand elasticity of each tobacco product. For cigarettes and RYO, price adjustments must be made cautiously, as they are close to the tipping point where additional increases could result in revenue declines.

4. Discussion

Our findings reveal that increasing taxes on cigarettes and RYO tobacco generates additional revenue, but this effect diminishes as prices approach a critical threshold where further increases could lead to declining revenue. The econometric analysis presented in Table 4 demonstrates statistically significant inverted U-shaped relationships between price and tax revenue for cigarettes and RYO tobacco, with linear price coefficients of 1.756 and 8.580, respectively, and negative squared price coefficients (-0.704 and -0.708), both significant at the 1% level. These results confirm that both products are approaching the apex of the Laffer Curve, suggesting limited scope for further tax increases without jeopardizing revenue. This aligns with the Laffer Curve framework, which highlights the trade-off between tax rates and fiscal returns. The limited margin for further price hikes on these products underscores the need for caution in policy adjustments, as excessive tax rates could suppress demand to a point that undermines fiscal goals. These results are consistent with other studies, such as those by Chaloupka et al. (2012), which have shown that while higher tobacco taxes are effective in reducing consumption and generating revenue, they face diminishing returns when tax rates exceed optimal levels.

For other tobacco products, such as pipe tobacco and cigars, the dynamics differ. The observed price sensitivity suggests that these products may have already surpassed their revenue-maximizing point on the Laffer Curve. Higher prices for these products result in significant demand reductions, eroding fiscal returns. This highlights a critical challenge: Ensuring that tax rates across all tobacco products are balanced to prevent consumers from substituting lower-taxed alternatives. Such a substitution not only diminishes the fiscal effectiveness of tobacco taxation but also weakens its role as a public health measure by sustaining overall consumption levels. Specifically, for pipe tobacco, the negative coefficient on the price variable (-3.851, $p < 0.01$) and the positive quadratic term (+0.557, $p < 0.01$) indicate that this product lies on the downward slope of the Laffer Curve. Hence, current taxation may be excessive relative to demand elasticity, resulting in diminishing returns. In contrast, the nearly null effect of price on cigars (coefficient = 0.009, non-significant) implies that revenue from this category is relatively insensitive to further tax changes.

While our analysis identifies that cigarette and RYO tobacco tax levels in Spain may be approaching the revenue-maximizing point, it is important to emphasize that maximizing revenue is not the sole or necessarily the optimal policy objective. In the presence of a dual mandate that includes fiscal sustainability and public health improvement, policymakers may rationally prefer to set tax rates above the Laffer peak. From a welfare perspective, the optimal tax rate is not defined solely by fiscal returns, but by the combined social benefits of reduced smoking prevalence and increased government revenue.

This view is supported by cost-benefit analyses in health economics, which highlight that marginal reductions in tobacco use can lead to significant long-term gains through lower morbidity,

improved productivity, and reduced public healthcare expenditures. Future research could formalize this policy trade-off by modeling a welfare-maximizing tax function that incorporates fiscal and health objectives. Such an extension would provide a more holistic framework for evaluating tobacco taxation and better reflect the complexity of real-world decision-making.

These findings carry significant implications for tobacco tax policy. First, while taxation remains an effective tool for generating revenue and reducing consumption, policymakers must carefully calibrate tax rates to avoid exceeding the Laffer threshold. For products nearing this point, incremental adjustments must consider elasticity variations and market responses to avoid counterproductive effects. Second, achieving equitable taxation across tobacco products is essential to limit substitution effects. Tax disparities encourage shifts toward cheaper, less-regulated alternatives, which can undermine public health objectives. Harmonizing tax structures across product categories can enhance both fiscal and health outcomes by ensuring consistent incentives to reduce consumption. Finally, demographic differences in consumption behavior must be factored into tax policy design. Demographic variables also exhibit significant effects on tax revenue. For example, the aging ratio has a negative and significant impact on cigarette (-0.372) and RYO (-0.573) tax revenues, suggesting that older populations may smoke less of these products or respond more strongly to price increases. Conversely, the youth ratio has a large and statistically significant negative effect on RYO and pipe tobacco revenues, indicating a greater elasticity of demand among younger individuals, which aligns with evidence from Chaloupka et al. (2012). Variations in demand elasticity by age group, income level, and smoking preferences influence the overall impact of taxation. For instance, younger populations might be more sensitive to price increases (Chaloupka et al., 2012; Hiscock et al., 2012), while older consumers may exhibit greater resistance to substitution. Tailoring tax policies to these demographic nuances can improve their effectiveness in achieving revenue and public health goals.

Beyond their fiscal and public health impacts, tobacco taxes have important implications for equity. Although tobacco taxation is often criticized for its regressive nature, disproportionately affecting low-income groups, emerging evidence suggests that, over time, the associated health gains and reduced medical costs may offset this burden, especially for the most vulnerable populations. Studies such as those by Gospodinov and Irvine (2009) and Divino et al. (2022) revealed that low-SES smokers tend to reduce consumption more strongly in response to price increases, leading to disproportionate long-term health and financial benefits.

Our findings reinforce this perspective, as demographic variables associated with socio-economic status, particularly the youth and aging ratios, show significant impacts on tax revenue, indicating differential responses across population segments. Although our dataset does not include direct SES indicators, the significant effect of demographic proxies suggests that targeted tax policies, complemented by cessation support and progressive reinvestment of tax revenues into public health, could enhance equity outcomes. Future research should integrate explicit SES indicators to model these distributive dynamics more precisely. However, the current results already point to the potential of fiscal policy to contribute to equity-oriented public health outcomes.

In addition to fiscal and behavioral outcomes, the long-term health and economic gains from tobacco taxation merit further emphasis. While we do not conduct a full cost-benefit analysis, evidence supports the notion that even marginal reductions in smoking prevalence translate into significant public health savings. For instance, Saenz de Miera et al. (2022) estimated that a modest tax increase in Mexico could prevent over 630,000 premature deaths and yield substantial reductions in treatment costs for tobacco-related diseases. Similarly, Pichon-Riviere et al. (2024) estimated that

comprehensive tobacco control in Latin America, including tax hikes, could generate economic benefits of up to \$63.8 billion through decreased healthcare spending and improved productivity.

Applying such insights to the Spanish context, where tobacco-related illnesses such as lung cancer and cardiovascular disease impose substantial costs on the national health system, suggests that the long-term health savings likely outweigh short-term fluctuations in tax revenue. Future research should entail microsimulation or extended cost-effectiveness modeling to more precisely estimate the fiscal-health trade-off under different taxation scenarios. This represents a promising avenue for future extensions of our research, as it would enable a more comprehensive evaluation of tobacco tax policy, combining fiscal and health outcomes within an integrated analytical framework.

Traditional tax policy often aims to “broaden the base and lower the rate” to improve efficiency and reduce distortions. However, in the case of tobacco taxation, where consumption generates substantial negative externalities, this principle requires a fundamental reinterpretation. Rather than automatically lowering rates, policymakers may consider broadening the base while raising where appropriate, particularly when the public health objective is central.

In this context, broadening the base does not necessarily imply uniform taxation across all tobacco products, but rather reducing large disparities in effective tax burdens that may incentivize harmful substitution. For example, narrowing the gap between the taxation of roll-your-own tobacco and manufactured cigarettes could reduce the incentive to switch purely for price reasons. Nonetheless, full harmonization must be weighed against the risk of encouraging illicit trade or informal supply channels, particularly if prices rise sharply or unevenly across products.

A balanced approach, where selective alignment of taxes is combined with gradual and predictable increases in rates, can help advance both fiscal and health objectives. This perspective illustrates how tobacco taxation may depart from standard tax design rules in order to better internalize externalities and support broader policy goals.

Our findings also align with evidence from other European countries, enhancing the generalizability of the results. For instance, France has successfully implemented substantial tobacco tax increases over the last two decades, combining specific and ad valorem taxes while regularly adjusting for inflation. This strategy has led to a significant reduction in smoking prevalence and an increase in fiscal revenue, although it also contributed to increased cross-border purchasing, especially near low-tax countries such as Spain and Luxembourg (Zeduri et al., 2023). In contrast, Germany has maintained relatively moderate tobacco taxes, with a greater emphasis on revenue stability than aggressive public health goals. This has resulted in comparatively smaller declines in smoking rates. Both cases underscore the importance of harmonized tax policies within the EU to prevent fiscal leakage and consumer substitution across borders. Incorporating these international experiences helps validate the relevance of the Laffer framework in diverse fiscal and regulatory contexts. Moreover, they suggest that the fiscal and public health recommendations drawn from the Spanish case may hold relevance for other EU countries facing similar challenges.

In conclusion, while tobacco taxes remain a powerful policy instrument, optimizing their impact requires a nuanced and evidence-based approach. Policymakers must navigate the fine balance between maximizing revenue and minimizing consumption while ensuring equity across products and addressing demographic influences. Addressing limitations such as illicit trade and the rise of alternative nicotine products is essential for enhancing the effectiveness of tax policies. By adopting a holistic approach, taxation can better achieve its dual objectives of fiscal sustainability and public health promotion.

However, it is important to note that the application of the Laffer Curve to tobacco taxation has conceptual limitations. Unlike traditional tax systems where the taxable base is relatively inelastic, tobacco consumption is subject to complex behavioral, demographic, and market dynamics. For example, the presence of illicit tobacco trade and the rise of alternative nicotine products (such as e-cigarettes) may distort the assumed relationship between price and revenue. These substitution effects may shift consumption outside of the formal, taxable market, thereby weakening the theoretical symmetry of the Laffer Curve. Furthermore, cross-border shopping and smuggling, particularly in border provinces, could cause tax revenue to decline before the theoretical optimum is reached, complicating revenue-maximization strategies.

While our dataset does not include disaggregated and reliable provincial-level data on e-cigarette use or illicit tobacco trade, thus preventing the direct integration of these variables into our econometric models, we acknowledge this as a limitation and highlight it as a priority for future research. Incorporating these dimensions would enable a more comprehensive assessment of fiscal and behavioral responses to tobacco taxation. Nevertheless, the variables and phenomena analyzed in this study capture the core dynamics of the formal, regulated tobacco market in Spain. As such, the absence of data on emerging nicotine alternatives or illicit trade does not materially compromise the validity of our results. In particular, our findings regarding the proximity to the Laffer Curve's revenue-maximizing point remain robust and offer meaningful insights to inform effective and evidence-based tax policy.

Despite its strengths, this study has some limitations. While we analyze the substitution effects between tobacco product categories, we do not delve into potential behavioral shifts toward non-tobacco alternatives, such as nicotine pouches or e-cigarettes. These emerging products may introduce additional complexities to tobacco taxation policy, requiring further exploration. Researchers should address this limitation by exploring the intersection of tobacco taxation and emerging nicotine products. As consumer preferences evolve, policymakers must consider how these alternatives interact with traditional tobacco markets and whether existing tax structures need adaptation. An additional limitation could be that this research is confined to Spain, limiting the generalizability of its findings to other countries with differing socio-economic contexts, tax structures, and regulatory environments. Comparative studies across regions could yield insights into how diverse settings influence the outcomes of tobacco taxation. Studies entailing the differential impacts of taxation across socio-economic groups, genders, and geographic regions could inform more targeted and equitable policy interventions.

Our results reinforce the dual role of tobacco taxation as both a public health tool and a revenue-generating instrument, aligning with prior findings in international and national studies. However, the diminishing returns at higher tax rates and the significant impact of substitution effects highlight the need for carefully calibrated, harmonized tax policies. Based on our econometric estimates, fiscal revenue from cigarettes and RYO tobacco in Spain appears to be approaching the peak of the Laffer Curve. Our results suggest that a marginal increase in the effective tax rate, quantified at approximately 5 to 8%, on these products could lead to moderate gains in revenue without significantly suppressing demand. However, beyond this threshold, further increases are likely to result in diminishing fiscal returns. In contrast, in the case of pipe tobacco, current tax levels appear to exceed the optimal point, indicating that a slight reduction in the tax burden or a reallocation of fiscal pressure toward other products might improve overall efficiency.

From a policy perspective, it is essential to ensure that tobacco taxation maintains its deterrent effect over time. One effective approach would be to automatically index tobacco taxes to inflation

and income growth. This mechanism would prevent the erosion of real prices and help preserve the public health impact of taxation without requiring frequent legislative adjustments.

Furthermore, excessive disparities in taxation across tobacco products, such as between manufactured cigarettes and RYO tobacco, should be avoided, as they can incentivize substitution strategies that undermine the effectiveness of tax policy. Nevertheless, full harmonization across products may have unintended consequences for revenue collection by encouraging consumers to shift toward cheaper alternatives or illicit channels. Therefore, any restructuring of the tax system should carefully consider these potential trade-offs, especially in contexts where the risk of smuggling or informal markets is present.

Rather than pursuing a uniform revenue-maximizing tax rate for all products, it would be more appropriate to define differentiated tax paths by product category, adjusted automatically for inflation. This approach respects the varying elasticities and consumption patterns across tobacco types while ensuring that the real fiscal pressure, and its associated health impact, is maintained over the long term.

Author contributions

All authors contributed equally to the conception, design, writing, and revision of the manuscript. All authors have read and approved the final version.

Use of AI tools declaration

The authors declare they have not used Artificial Intelligence (AI) tools in the creation of this article.

Conflict of interest

All authors declare no conflicts of interest in this paper.

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