Original Research

Price and income elasticities of demand for cigarette consumption: what is the association of price and economic activity with cigarette consumption in Spain from 1957 to 2016?

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ABSTRACT

Objectives: Extensive empirical and theoretical studies have been devoted to analyzing the relationship between tobacco and income. The price and income elasticities of demand for cigarette consumption are the main focus of studies in this body of literature. However, few empirical studies exist that analyze how economic growth affects the cigarette market, and no one has studied the effects of economic expansions and recessions. Spain, as in the other countries of the European Union, has suffered a strong recession since 2008. Therefore, this article aims to detect if income elasticity takes different values in economic growth and recession and, in addition, to check whether price elasticity in Spain is consistent with previous studies.

Study design: This is an observational epidemiological study.

Methods: In this article, the price and income elasticities of demand for cigarette consumption are measured for the Spanish cigarette market using time series data from 1957 to 2016 and by applying a non-linear autoregressive dynamics lag model. The novel specification proposed in this study is the determination of the possible effects of asymmetries in the economic shocks on cigarette consumption.

Results: Our results reveal that cigarette consumption maintains a notable asymmetric relationship. In particular, our results show that in expansion shocks, cigarette consumption increases (a 10% economic growth is associated with a 4.05% increase in cigarette consumption), whereas in recession shocks, cigarette consumption decreases dramatically, with a more pronounced pattern in recession phases than in expansion phases (a 10% economic decline is associated with a 58.16% decrease in cigarette consumption). On the other hand, price elasticity maintains the same behavior shown in the previous literature (a 10% price increase is associated with a 2% decrease in cigarette consumption).

Conclusions: Higher cigarette prices are associated with decreased smoking. In addition, the economic recession helps in decreasing cigarette consumption. Therefore, it is strongly recommended that tax authorities have our results in mind before establishing health policies. If the authorities do not, it is possible that they will not obtain the expected results in terms of decreased tobacco consumption.

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Introduction

Extensive empirical and theoretical studies have been devoted to analyzing the relationship between tobacco, the economy, and health, most intensively in middle- and high-income countries. This interest emerges from the fact that tobacco use causes several types of cancer as well as cardiovascular disease, respiratory disease, reproductive disorders, and many other ill health effects...
and has an addictive nature. Indeed, tobacco represents an important part of high-income nations’ budgets, in which 16.6% of the population older than 15 years smokes daily and health spending is approximately 11.5% of the national gross domestic product (GDP) on average. Although tobacco has an addictive nature, there is an inverse relationship between the price of tobacco products and consumption. Therefore, policymakers and academics, aiming to manage the levels of tobacco consumption, have analyzed different ways to control it, such as by passing laws that prohibit smoking, or on the supply side, manufacturers of tobacco products and retailers can maintain prices or promote tobacco products to keep demand high. Nevertheless, the most effective tool for controlling tobacco demand is price elasticity. In other words, by increasing tobacco taxes, tobacco consumption is reduced. Consequently, a large number of articles have been published to determine the elasticities of tobacco consumption and price.

In this context, theoretical models have been developed to determine the optimal tax by maximizing a welfare function that considers the impact of the tax on the demand and therefore on the social costs generated by the goods itself. From an empirical point of view, a number of studies have been performed on the relationship between prices and tobacco consumption. Furthermore, the studies that measure cigarette consumption in the long term mainly focus on the two elasticities of tobacco consumption with prices and income, as measured by economic growth (GDP). An early study in the 1980s based on cross-sectional data from 27 European countries showed a price elasticity of −0.4 and an income elasticity of demand of 0.5. More recently, some articles have revealed how a one percent increase in income is associated with an increase of 0.39–0.43% in cigarette consumption. In addition to the relationship between cigarette consumption and GDP, the literature has also indirectly studied the relationship between the economic cycle and tobacco consumption, linking, for instance, unemployment with smoking (see among others the studies by Montogomery et al., Lee et al., Hammarstrom and Janler, DeVogli and Santinello, and Bambra and Eikemo). Overall, economic recessions affect the consumption of cigarettes, so the role played by economic cycles in the behavior of tobacco consumption seems evident. However, the asymmetries of the influence of economic cycles on the consumption of each type of tobacco have not been studied.

Although elasticity is a widely studied topic, none of these studies have considered how this relationship behaves in the face of different shocks that may affect economies, i.e., the tobacco market is not symmetrical because it depends on shocks that affect the economy. Furthermore, in the case of Spain, the most recent study analyzing the price elasticity of cigarettes was published in 2004, considering data for the period 1965–2000. There is no evidence in the literature to try to clarify, for example, how the crisis has affected the relationship with cigarette consumption.

To the best of our knowledge, in this article, the price and income elasticities of demand for cigarette consumption in the case of Spain are studied under a novel framework that considers nonlinear patterns. This novelty is due to two main reasons. First, analysis of asymmetries in the long-term relationship of this elasticity is novel. By applying the non-linear autoregressive dynamics lag (NARDL) model proposed by Shin et al., we can determine the elasticities of cigarette consumption prices and cigarette consumption income by considering how they vary according to negative or positive economic shocks. Second, we tested this long-term relationship by contemplating a time span that has not been studied until now, between the years 1957 and 2016, including recent years and consequently measuring the effects of the 2007 financial crisis. This long time span allows the measurement of the possible impacts of those asymmetries in the recent relationship.

In summary, the study in Spain is useful for three reasons. First, an update is made on the price and income elasticities of demand for cigarette consumption, a topic that has not been analyzed for almost two decades. Second, it is the first time that an elasticity analysis has been conducted using all available historical data. Finally, this work provides an instrument for policymakers to implement heterogeneous policies in economic expansions and recessions.

Table 1 shows a review of the empirical studies of this body of literature. It is verified that, in general, two different approaches have been used, depending on the temporal structure of the data. On the one hand, using microdata, researchers try to measure the influence of demographic and income issues on tobacco consumption. On the other hand, most studies that have been devoted to the analysis of the elasticities of cigarette consumption and income have used time series data, applying several techniques, such as the vector error correction model or autoregressive distributed lag (ARDL) cointegration. These empirical estimates of cigarette demand have shown that cigarette consumption and prices behave in an inelastic manner; in other words, the variations in the quantity consumed are less than proportional to changes in prices. Furthermore, Becker and Murphy’s ‘theory of rational addiction’ and the meta-analysis performed by Gallet and List support that the price elasticity of cigarette demand is greater in the long term than in the short term. In particular, this value is around the −0.4 for high-income countries. For instance, in the Spanish case, this elasticity is −0.19, whereas in other countries, such as Argentina, this elasticity is −0.31; in the UK, it is −0.36; in Finland, it is −0.49; in Italy, it is −0.43; in Canada, it is −0.5; in Australia, it is −0.3. In Germany, a one euro cent increase is associated with an overall reduction in the per capita consumption of approximately 28 cigarettes per quarter. Furthermore, lower income smokers are more sensitive to the price of cigarettes than higher income smokers. On the other hand, empirical studies that have quantified the economic growth and tobacco consumption elasticity have showed robust results with positives elasticities. Finally, it should be noted that the need to know about the relationship between cigarette consumption and price is a topic that continues to concern academics and policymakers in the current situation.

Methods

To develop our empirical analysis, we have used the annual per capita (population aged ≥10 years) cigarette consumption for the period 1957–2016 from annual tobacco official sales as published by Tabacalera S.A. and the Commission for Trade of Tobacco (Comisionado para el Mercado de Tabacos) and population estimates from the study by Prados de la Escosura. The average price of 20 cigarettes, in current euros, was directly obtained from the

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1. The main substitute product of cigarettes is roll-your-own (RYO) tobacco. If RYO tobacco is a suitable and cheaper alternative for manufactured cigarettes, then price increases, with the aim of reducing the overall demand; however, it could instead lead to some smokers substituting for the cheaper RYO tobacco (see the study by Cornelsen and Normand).

2. All articles published before 2004 from Spain are summarized in the study by Prilina, in which several articles show that the price elasticity of cigarettes is estimated to be between −0.17 and −0.36.

3. A 10% increase in price causes a 4% decrease in demand.
same official reports. The price of cigarettes was thereafter adjusted for inflation (in euros, standardized at the year 2010) to obtain the real price of a pack of cigarettes. We also used the annual per capita GDP (in euros, standardized at the year 2010). As a preview on the selected variables, Fig. 1 presents a graphical analysis of the time series dynamics plotted for the Spanish tobacco market. Over the years, different tax rates on tobacco products have been transferred to retail prices in Spain. Associated with the tax burden, the evolution of prices and their consequent effect on consumption lead to three distinct stages: the first, until 1992, when prices increased slightly and consumption remained stable; the second, between 1992 and 2006, when prices rose more sharply, although stability in consumption was maintained; and the third, between 2006 and 2016, when prices grew substantially, coinciding with an important fiscal change that occurred in 2006—the establishment of a mandatory minimum tax for cigarettes that prevents the commercialization of cheap brands. In this last stage, between 2006 and 2016, prices of a pack of 20 units of manufactured cigarettes increased by more than 84%, causing a sharp fall in consumption. Fig. 1 illustrates the long-term relationship among cigarette sales, GDP, and prices in Spain, in which it is clear that the relationship among the three variables presents a similar trend. However, from 2008, this relationship produces a radical change in cigarette sales accompanied by the fall of GDP.

Based on the theory of demand, cigarette consumption is a function of the real price and per capita of the real income. Furthermore, two regulatory changes have been considered: in 2006, a partial smoke-free ban was imposed under Act 28/2005 on tobacco control; then, in January 2011, a total smoke-free ban was coincide with an important change that occurred in 2006—the establishment of a mandatory minimum tax for cigarettes that prevents the commercialization of cheap brands. In this last stage, between 2006 and 2016, prices of a pack of 20 units of manufactured cigarettes increased by more than 84%, causing a sharp fall in consumption. Fig. 1 illustrates the long-term relationship among cigarette sales, GDP, and prices in Spain, in which it is clear that the relationship among the three variables presents a similar trend. However, from 2008, this relationship produces a radical change in cigarette sales accompanied by the fall of GDP.

Based on the theory of demand, cigarette consumption is a function of the real price and per capita of the real income. Furthermore, two regulatory changes have been considered: in 2006, a partial smoke-free ban was imposed under Act 28/2005 on tobacco control; then, in January 2011, a total smoke-free ban was implemented by Act 42/2010. According to the study by Pinilla et al., dummy variables were coded for each case, with values of 0 and 1 for before and after the entry into force of each law, respectively. The following model is estimated:

$$Q_t = \alpha_0 + \alpha_1 P_t + \alpha_2 Y_t + \alpha_3 D_{28/05} + \alpha_4 D_{42/10} + \epsilon_t$$  \hspace{1cm} (1)$$

where $Q_t$ is the cigarette consumption, $P_t$ is the real average price, and $Y_t$ is the real GDP per capita, $D_{28/05}$ and $D_{42/10}$ represent

### Table 1

<table>
<thead>
<tr>
<th>Study</th>
<th>Country or countries</th>
<th>Data source or data sources</th>
<th>Methodology</th>
<th>Price elasticity</th>
<th>Income elasticity</th>
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<tbody>
<tr>
<td>Varona-Perez et al.</td>
<td>Cuba</td>
<td>Cuba National Health Surveys</td>
<td>OLS</td>
<td>-0.31</td>
<td>N/A</td>
</tr>
<tr>
<td>Fuchs and Meneses</td>
<td>Moldova</td>
<td>National Bureau of Statistics of Moldova</td>
<td>Cost-benefit analysis</td>
<td>-0.33</td>
<td>N/A</td>
</tr>
<tr>
<td>Mukong and Tingum</td>
<td>South Africa</td>
<td>South African National Income</td>
<td>Tobit model</td>
<td>-0.43</td>
<td>N/A</td>
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<tr>
<td>Stoklosa et al.</td>
<td>Zambia</td>
<td>International Tobacco Control (ITC) Zamba Survey</td>
<td>Probit model</td>
<td>-0.2</td>
<td>N/A</td>
</tr>
<tr>
<td>Rodríguez-Iglesias et al.</td>
<td>Argentina</td>
<td>Ministry of Agriculture</td>
<td>Cointegration</td>
<td>-0.28</td>
<td>0.41</td>
</tr>
<tr>
<td>Suárez-Lugo et al.</td>
<td>Cuba</td>
<td>Oficina Nacional de Estadísticas e Información de Cuba</td>
<td>Descriptive analysis</td>
<td>-0.1</td>
<td>N/A</td>
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<tr>
<td>Yeh et al.</td>
<td>EU</td>
<td>Euromonitor International</td>
<td>Threshold regression method</td>
<td>[-0.501, -1.227]</td>
<td>[0.282, 0.576]</td>
</tr>
<tr>
<td>Chávez</td>
<td>Ecuador</td>
<td>Encuesta Nacional de Ingresos y Gastos de Hogares Urbanos y Rurales</td>
<td>Deaton approach</td>
<td>-0.87</td>
<td>N/A</td>
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<tr>
<td>Ramos-Carbajales et al.</td>
<td>El Salvador</td>
<td>Dirección General de Estadística y Censos</td>
<td>Cointegration</td>
<td>-0.93</td>
<td>0.99</td>
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<td>Guindon et al.</td>
<td>Latin America</td>
<td>Multidata</td>
<td>Pooled data</td>
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<td>N/A</td>
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<td>Liu et al.</td>
<td>China</td>
<td>Global Market Information</td>
<td>OLS</td>
<td>-0.49</td>
<td>N/A</td>
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<tr>
<td>Martínez et al.</td>
<td>Argentina</td>
<td>Year Book</td>
<td>Cointegration</td>
<td>-0.31</td>
<td>0.43</td>
</tr>
<tr>
<td>Chaloupa and Tauras</td>
<td>Ireland</td>
<td>Office of Revenue Commissioners</td>
<td>OLS</td>
<td>[-1, -2.3]</td>
<td>N/A</td>
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<tr>
<td>Mushtaq et al.</td>
<td>Pakistan</td>
<td>Ministry of Finance and from US Department of Agriculture, Pakistan Tobacco Board and UN Comtrade</td>
<td>ARDL</td>
<td>-1.17</td>
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<td>Ross et al.</td>
<td>Ukraine</td>
<td>Ukrainian Ministry of Health</td>
<td>OLS</td>
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<td>0.24</td>
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<tr>
<td>Gallus et al.</td>
<td>Multicountry</td>
<td>Multidata</td>
<td>Double-log multiple linear regression</td>
<td>[-0.19, -0.50]</td>
<td>N/A</td>
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<tr>
<td>Huang and Yang</td>
<td>US</td>
<td>Tobacco Institute</td>
<td>Threshold regression method</td>
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<td>N/A</td>
</tr>
<tr>
<td>Sheu et al.</td>
<td>US (California)</td>
<td>California Department of Health Services</td>
<td>Probit model</td>
<td>-0.5</td>
<td>N/A</td>
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<tr>
<td>Lance et al.</td>
<td>China</td>
<td>China Health and Nutrition Survey</td>
<td>Probit model</td>
<td>-0.54</td>
<td>N/A</td>
</tr>
<tr>
<td>Tal and Seldon</td>
<td>Estonia</td>
<td>Statistical Office of Estonia</td>
<td>OLS</td>
<td>-0.34</td>
<td>0.09</td>
</tr>
<tr>
<td>Kim and Seldon</td>
<td>South Korea</td>
<td>Korea National Statistical Office</td>
<td>Non-linear least squares instrumental variable regressions</td>
<td>-0.35</td>
<td>N/A</td>
</tr>
<tr>
<td>Fernández et al.</td>
<td>Spain</td>
<td>Official sales as published by Tabacalera and the Commission for Trade of Tobacco</td>
<td>OLS</td>
<td>-0.19</td>
<td>0.42</td>
</tr>
<tr>
<td>Gruber et al.</td>
<td>Canada</td>
<td>Canadian Survey of Family Expenditure (FAMEX)</td>
<td>Probit model</td>
<td>-0.45</td>
<td>N/A</td>
</tr>
<tr>
<td>Saygınsoy et al.</td>
<td>Bulgaria</td>
<td>World Bank Office in Bulgaria</td>
<td>OLS</td>
<td>-0.8</td>
<td>0.34</td>
</tr>
<tr>
<td>Onder</td>
<td>Turkey</td>
<td>U.S. Department of Agriculture</td>
<td>Generalized least squared (GLS)</td>
<td>-0.19</td>
<td>0.23</td>
</tr>
</tbody>
</table>

ARDL = autoregressive distributed lag; OLS, ordinary least squares.

*Elasticities referred to long-term cigarette consumption. See the study by Pinilla for a summary of previous empirical findings to 2002.
regulatory changes, ε is the error term, and \((α_0, α_1, α_2, α_3, α_4)\) is a vector of long-run parameters to be estimated. The general form of the unrestricted error correction model, to generate short-term and long-term elasticities, is the autoregressive distributed lag (ARDL) approach given as follows:

\[
\Delta Q_t = \beta_0 + \beta_1 Q_{t-1} + \beta_2 P_{t-1} + \beta_3 Y_{t-1} + \beta_4 D_{28/05} + \beta_5 D_{42/10} + \sum_{i=1}^{p} \beta_6 \Delta Q_{t-i} + \sum_{i=0}^{q} \beta_7 \Delta P_{t-i} + \sum_{i=0}^{r} \beta_8 \Delta Y_{t-i} + \varepsilon_t
\]

(2)

where all the variables are as defined previously and \(p, q,\) and \(r\) are the lag orders.

As we mentioned, our empirical strategy aims to measure the impact of asymmetries on cigarette consumption. Following the study by Shin et al. we can extend the ARDL to account for asymmetries, introducing the NARDL model. Equation (1) is transformed in the following asymmetric long-run equation:

\[
Q_t = α_0 + α_1 P_{t-1}^+ + α_2 P_{t-1}^- + α_3 Y_{t-1}^+ + α_4 Y_{t-1}^- + α_5 D_{28/05} + α_6 D_{42/10} + \varepsilon_t
\]

(3)

where \((α_1^+, α_2^+, α_3^+, α_2^-)\) is the associated asymmetric long-run parameters and \(P_t^+, P_t^-, Y_t^+, Y_t^-\) are partial sums of positive and negative changes in \(P_t\) and \(Y_t\), respectively:

\[
P_t^+ = \sum_{i=1}^{t} \Delta P_i^+ = \sum_{i=1}^{t} \max(\Delta P_i, 0) \quad P_t^- = \sum_{i=1}^{t} \Delta P_i^- = \sum_{i=1}^{t} \min(\Delta P_i, 0)
\]

\[
Y_t^+ = \sum_{i=1}^{t} \Delta Y_i^+ = \sum_{i=1}^{t} \max(\Delta Y_i, 0) \quad Y_t^- = \sum_{i=1}^{t} \Delta Y_i^- = \sum_{i=1}^{t} \min(\Delta Y_i, 0)
\]

Then, the following asymmetric error correction model is given as follows:

\[
\Delta Q_t = \beta_0 + \beta_1 Q_{t-1} + \beta_2 P_{t-1}^+ + \beta_3 P_{t-1}^- + \beta_3 Y_{t-1}^+ + \beta_4 Y_{t-1}^- + \beta_4 D_{28/05} + \beta_5 D_{42/10} + \sum_{i=1}^{p} \beta_6 \Delta Q_{t-i} + \sum_{i=0}^{q} \beta_7 \Delta P_{t-i}^+ + \beta_7 \Delta P_{t-i}^- + \sum_{i=0}^{r} \beta_8 \Delta Y_{t-i}^+ + \beta_8 \Delta Y_{t-i}^- + \varepsilon_t
\]

(4)

In summary, we use the following steps. First, we estimate the equations using the ordinary least squares (OLS). The optimal lag length is selected using the general-to-specific criterion. Second, we perform the NARDL cointegration tests for the presence of a relative dynamic multiplier effects on \(P_t\) and \(Y_t\), respectively, as follows:

\[
m^h = \sum_{i=0}^{h} \frac{∂y_{t+i}}{∂P_t} \quad m^h = \sum_{i=0}^{h} \frac{∂y_{t+i}}{∂Y_t} \quad n^h = \sum_{i=0}^{h} \frac{∂y_{t+i}}{∂P_t} \quad s^h = \sum_{i=0}^{h} \frac{∂y_{t+i}}{∂Y_t}
\]

Results

In this section, according to the described econometric strategy, we present the estimation results to investigate the elasticities of

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**Fig. 1.** Annual per capita (population aged ≥16 years) consumption of cigarettes, real price (euros 2010) of cigarettes and annual per capita (population aged ≥16 years) GDP, Spain, 1957–2016. GDP = gross domestic product.
cigarette consumption prices and cigarette consumption income and the asymmetric behaviors. In the first step, we use the test for the cointegration in the NARDL model. Second, we proceed with the non-linear approach and check long and short-run asymmetries. The results of these approaches are reported and distinguished by the direction of the relationship. The estimation results are presented in Table 5, which shows the price and income elasticities considering the asymmetric effect.

Before we proceed with the analysis, we need to investigate the order of integration of our series. Table 2 shows that all of the series appear to be integrated or of order one, i.e., none of the variables are found to be $I(2)$, so the necessary condition to apply the NARDL approach is met. Table 3 provides the FPSS and $t_{BDM}$ statistics testing non-linear cointegration relationships and displays the results of the bounds testing procedure for cointegration between the variables. The FPSS and $t_{BDM}$ statistics for the NARDL approach reveal that either the F-test or t-test statistic or both reject the null hypothesis of no cointegration at the significance level of 1%. This result implies that there are long-run non-linear relationship between cigarette consumption, cigarette price, and GDP.

In a previous step to report the long-run coefficients, we performed Wald tests for the possibility of short- and long-run symmetries in each variable ($P_t$ and $Y_t$) to select the best suited specification. Table 4, which summarizes the Wald test results, shows that short- and long-run asymmetries exist only in $Y_t$, whereas $P_t$ is found to be linear.\(^{(5)}\) This result is shown in Fig. 1, according to which the price of a pack of 20 units of cigarettes did not increase or decrease significantly from 1957 to 1992. Since 1992, the price has experienced a strong growth. Given the positive trend presented by the series, it is consistent that the price variable does not present asymmetries.

Following our empirical strategy, we completed the analysis of the long-run dynamics (see Table 5). The estimated long-run coefficients $Y'_t$, $Y_t$, and $P_t$ are presented at the bottom part of Table 5. All of the coefficients are significant at the 1% level. The estimates of these coefficients showed that there would be a negative effect of price on the demand for cigarettes and a positive effect of income (positive and negative shocks) on the demand for cigarettes. In summary, the estimated long-term price elasticity indicated a 1.93% decrease in cigarette demand for a 10% increase in cigarette price.

On the other hand, a 1% increase in income increased the cigarette demand by 0.403%, but a 1% decrease in income decreased the cigarette demand by 3.595% in the long term.

Finally, the asymmetric dynamic relationship between the analyzed variables further enriches the elasticity analysis. The cumulative dynamic multipliers (see Fig. 2) show the adjustments of cigarette consumption in the face of a shock in GDP per capita. This figure depicts the adjustment pattern of the cigarette sales to a negative or positive unitary shock in the GDP per capita. The discontinuous black line shows the effect of a positive shock, and the continuous black line shows the effect of negative shocks. The general effect, without differentiating between positive and negative shocks, is represented by the thick continuous line. The graph confirms that the impact of the GDP per capita decrease on cigarette sales is relatively higher than the impact of the GDP per capita increase.

Overall, our results support different patterns among expansion and recession—non-linear behavior—in the consumption of cigarettes and income. Our most significant contribution is on the strong reaction that occurs in the consumption of cigarettes during recessions.

**Discussion**

In recent years, there has been a growing interest among academics, practitioners, and policymakers to understand the mechanisms that can control cigarette consumption due to the large impact of cigarettes, not only for health management but also for their effects on the budgets of countries via collection and health costs. In this context, the empirical literature devoted to the analysis of the effectiveness of economic policy tools concludes that the most effective policies are sustained in the intervention of cigarette prices through taxes. Therefore, the elasticity of demand for cigarettes and prices is the main focus of studies in this body of literature. However, few empirical studies exist that analyze how economic growth affects the cigarette market, and no one has studied the effects of economic expansions and recessions. In this article, the effect of the economic cycle on cigarette consumption has been explored in a novel way for a broad time span, while the relationship between consumption and price has been tested by analyzing their elasticities.

In our article, by using an NARDL model, we reveal that cigarette consumption maintains an asymmetric relationship depending on the cycle of the economy. Although the results in growth phases are robust according to the previous evidence and cigarette consumption increases when there is GDP growth, with an elasticity of 0.403, this pattern does not occur in depressive phases, in which the elasticity is 3.595. Our results maintain that in Spain, in recession phases, cigarette consumption decreases dramatically. Furthermore, this behavior is much more pronounced in recession phases, which confirms that the market is notably asymmetric. Similarly, application of this exercise has also shown stable results in relation to the previous literature, with a price elasticity of −0.193.

The findings obtained in this article could provide arguments for economic agents to design their control policies on this market. Thus, if the government claims that cigarette sales do not grow, the price should grow more than double the GDP. Specifically, to cancel the effect that causes the increase of one percent of GDP in the cigarette market, the price should grow by 2.09%. Given the average price of a pack of 20 units of cigarettes in 2017, the price should increase by 11 cents for each increase of one percent in GDP. On the other hand, to recover the reduction of one percent of GDP, cigarette sales would need to increase by 9.83% in income in subsequent periods, keeping the price constant. From this perspective, it

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\(^{(5)}\) We estimate the NARDL model as in Equation (4) using standard OLS. We drop the insignificant regressors of the first-differenced terms using the general-to-specific procedure. We start with $P = 4$ and $q = 4$. 

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**Table 2**

Ng-Perron unit root test.

<table>
<thead>
<tr>
<th>Variables (in logs)</th>
<th>$l(1)$ vs. $l(0)$</th>
<th>$l(2)$ vs. $l(1)$</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>$M_{Z}^{GLS}$</td>
<td>$M_{Z}^{GLS}$</td>
</tr>
<tr>
<td>GDP pc</td>
<td>0.091</td>
<td>-16.851***</td>
</tr>
<tr>
<td>Sales</td>
<td>1.025</td>
<td>-18.817***</td>
</tr>
<tr>
<td>Price</td>
<td>-2.506</td>
<td>-24.644***</td>
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<tr>
<td></td>
<td>0.051</td>
<td>-3.052***</td>
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<tr>
<td></td>
<td>0.557</td>
<td>0.162***</td>
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<td></td>
<td>31.847</td>
<td>0.995***</td>
</tr>
</tbody>
</table>

$GDP =$ gross domestic product.
The critical values for the Ng-Perron test are tabulated in the study by Ng and Perron (2001).\(^{(4)}\) The bandwidth selection is defined by using the Bartlett kernel, as suggested by the Newey-West test (1987).\(^{(5)}\)

***Significance at the 1% level.
**Significance at the 5% level.
*Significance at the 10% level.
and Banerjee et al. (1998), respectively, for testing the null hypothesis of no cointegration in the linear and non-linear model. The critical values for these statistics have been obtained from Pesaran et al. (2001).

**Rejection of the null hypothesis of no cointegration at the 5% level.**

***Rejection of the null hypothesis of no cointegration at the 1% level.

Table 3

<table>
<thead>
<tr>
<th>Bound test for cointegration in the NARDL model.</th>
</tr>
</thead>
<tbody>
<tr>
<td>NARDL model</td>
</tr>
<tr>
<td>FPSS</td>
</tr>
<tr>
<td>$f_{BDM}$</td>
</tr>
<tr>
<td>7.832***</td>
</tr>
<tr>
<td>-4.584***</td>
</tr>
</tbody>
</table>

NARDL – non-linear autoregressive distributed lag.

FPSS and $f_{BDM}$ denote the F-statistics and t-statistics proposed by Pesaran et al. (2001) and Banerjee et al. (1998), respectively, for testing the null hypothesis of no cointegration in the linear and non-linear model. The critical values for these statistics have been obtained from Pesaran et al. (2001).

**Rejection of the null hypothesis of no cointegration at the 5% level.**

***Rejection of the null hypothesis of no cointegration at the 1% level.

Table 4

<table>
<thead>
<tr>
<th>Wald test for long-run and short-run asymmetry.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variables</td>
</tr>
<tr>
<td>Price</td>
</tr>
<tr>
<td>GDP pc</td>
</tr>
<tr>
<td>Selected specification</td>
</tr>
<tr>
<td>NARDL with LR in GDP</td>
</tr>
<tr>
<td>per capita and SR symmetry</td>
</tr>
<tr>
<td>in GDP and price.</td>
</tr>
</tbody>
</table>

NARDL – non-linear autoregressive distributed lag; GDP – gross domestic product.

The table shows the results of the short- and long-run symmetry tests. $W_{LR}$ denotes the Wald test for the long-run symmetry; $W_{SR}$ denotes the Wald test for the short-run symmetry. The associated $P$-values are in brackets.

*Rejection of the null hypothesis of short- and long-run symmetry at the 1% level.

**Rejection of the null hypothesis of short- and long-run symmetry at the 1% level.

does not seem to be possible to act on a price reduction because the fiscal reform of 2012 introduced the double-minimum measure, making it impossible, in practical terms, to lower the package price of 3.92 euros. In addition, from a health perspective, this alternative does not seem viable either.

It is clear that although the recommendations for a tax increase must be connected to an increase in GDP from an economic perspective, there are other constraints, such as the double-minimum excise mentioned previously, that would not allow a decrease in excises and, therefore, in cigarette prices when the GDP decreases. There are other external factors that can complete the analysis in the case of Spain and, by extension, all of Europe. These factors are mainly strong awareness about diseases associated with tobacco consumption that makes smokers reduce or abandon this habit and the strong restrictions on tobacco consumption that different legislations have introduced in many countries, such as Spain, where since 2011, tobacco consumption is prohibited in closed spaces. The results from this analysis make it easier for tax authorities to implement an increase in cigarette excises when the GDP increases. Nevertheless, it is also important for policymakers to keep in mind that lower income smokers are more sensitive to the price of cigarettes than higher income smokers. In periods when the GDP is increasing, they must check the changes in the tax cigarette structure that will be implemented. If the one that is applied makes cheaper brands increase prices higher than premium brands, the governments may not achieve their budget aims.

In an effort to summarize the practical policy implications that the results of this article have for policymakers, these can be summarized in three points. The first implication is that governments have many instruments to control legal cigarette sales. Both the price and regulation of smoking and economic austerity measures have a negative effect on legal cigarette sales. Second, policymakers should consider that the regulation against smoking leads to fewer sales of legal cigarettes, but this does not have to mean less consumption of tobacco. Governments must control the behavior of substitute products, both legal and illegal, when establishing restrictive tobacco policies. Finally, in times of economic recessions, there is a large drop in legal cigarette sales. At these stages, governments must expand surveillance of illegal trade because if legal cigarette sales fall and consumers turn to illegal alternatives, the impact on public health may be relevant.

A natural extension of this work for future research would be to test the cross-elasticities with the substitute products for cigarettes.
considering the asymmetric effects, which would give us an answer as to whether the dramatic change in behavior observed in the cigarette market is due to a change in the behavior of consumers toward these substitute products, which include legal tobacco products, such as fine-cut tobacco or pipe tobacco, and even illegal products. Furthermore, another extension may be to analyze if the asymmetry in income elasticity shown in this article is different depending on the interest group (such as young people, men, women, or the unemployed). Another future line may be to include the effect of the cross-border trade and smuggling. It would also be interesting to analyze the relationship between official cigarette sales and smoking prevalence measured using individual data. Finally, a spatial analysis that allows studying the elasticity of each region can also add value to the existing literature.

Author statements

Ethical approval

No ethical approval was required as the analysis used summary statistics from national agencies, with no individual patient-level data.

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Competing interests

None declared.

References

2. DHHS. The health consequences of smoking: a report of the surgeon general. Atlanta, GA: DHHS, CDC, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health; 2004.


