Short Communication

A spatial analysis of the Spanish tobacco consumption distribution: Are there any consumption clusters?

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ABSTRACT

Objectives: The objective of this short communication is to provide a previous empirical analysis to locate the regions that have distortions in per capita tobacco consumption. The location of these regions and their proximity to other countries allow us to detect the need that governments have to harmonize policies.

Study design: The design of this study is a cross-sectional spatial descriptive analysis.

Methods: By using panel data from the 47 Spanish provinces from 2002 to 2017, we implement the Moran’s I test which allows us to detect areas where low or high per capita tobacco consumption clusters are generated.

Results: The results show that areas of Spain bordering countries with high price differentials, such as Gibraltar and France, generate clusters of low and high per capita tobacco consumption, respectively. Indeed, maintaining a low price differential seems not to generate distortions, as revealed by the Portugal case.

Conclusions: Spatial clusters of per capita tobacco consumption are located in regions close to countries where there is high price differential.

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Introduction

Economic convergence in Europe has been an important issue since the establishment of the trade and customs unions has led to many efforts being made to reduce the policy inequalities. Indeed, analyze some sectors that, due to failures in cooperation between countries legislation, may have cross-border activity with relevant consequences on policy effectiveness. In particular, the most regulated products can suffer the consequences of the lack of cooperation between governments. For example, the tobacco market and its firm government regulation to reduce health consequences have been analyzed over time by several academics focusing on the European Union and Spain due to the existence of cross-border cigarette purchases between countries in those locations. Tobacco price differential across the European Union creates a favorable environment for cross-border cigarette purchases, where the spatial distribution of tobacco consumption plays an important role in detecting it.

Although there are studies that have uncovered the cross-border purchases of cigarettes, few studies have analyzed the tobacco consumption distortions that it generates. A very recent study finds that price differentials constitute the main issue that generates cross-border purchases, and policymakers should use tax harmonization between countries to discourage it. In this body of literature, our study focuses on Spain where, through spatial analysis, we can detect distortions in the spatial distribution of per capita tobacco consumption. It is important to note that this analysis is possible because in Spain the price is established by the national government and is the same for all regions.

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Methods

To develop our empirical analysis, we used panel data from the 47 Spanish provinces from 2002 to 2017 (Canary Island, Balearic Island, and Ceuta and Melilla are treated as islands as usual in the literature of spatial analysis). We used the annual official tobacco sales as published by the Tobacco Market Commission of Spain, and we have divided them among the population aged 18 years and older to calculate per capita tobacco consumption. The population aged 18 years and older is available in the National Institute of Statistics in Spain.

We analyze the behavior of per capita tobacco consumption in the various regions, implementing the local version of Moran’s I statistic for each region and year. This method allows us to detect spatial cluster formation with significant high or low per capita tobacco consumption:

$$I = \frac{X_i - \bar{X}}{S_i} \sum_{i=1}^{n} w_{ij} (X_j - \bar{X})$$

where $X_i$ and $X_j$ are observations of the per capita tobacco consumption of regions $i$ and $j$, respectively, $\bar{X}$ is the average between regions, $n$ is the number of regions, $w_{ij}$ is the $ij$ element of the weight matrix, and $S_i$ is given as follows:

$$S_i = \sum_{i=1}^{n} (X_j - \bar{X})^2$$

We estimate this test with 20 different weight matrices including contiguity matrices (rook and queen of order 1 and 2), distance matrix (150 km, 200 km, 250 km, 300 km, and inverse matrices), and $k$-nearest neighbors matrices (with $k = 2$, $k = 3$, $k = 4$, and $k = 5$). All matrices produced similar results, so we decided that the first-order contiguity matrix is the one that better reflects these spillovers between provinces because of its simplicity and not having to make arbitrary considerations about whether there are relationships beyond the provinces with which borders are shared.

A positive and significant value allows us to find spatial clusters of similar per capita tobacco consumption. In sum, we estimate 752 tests for each region and each year. We use this information to implement a hot and cold spot analysis. This analysis presents on a map the location of the clusters found. Significant clusters of high sales are called ‘hot spot’, and significant clusters of low sales are called ‘cold spot’. Through this analysis, we can detect where the clusters of regions with high or low per capita tobacco consumption are located.

Before performing the hot and cold spot analysis, we estimated whether there is spatial dependence between the provinces throughout the period analyzed (2002–2017) using the Cross-sectional Dependence (CD) test developed by Pesaran, whose null hypothesis is the absence of strong spatial dependence between regions. The result of this test is $CD = 130.882$ and $p-value = 0.000$, so the null hypothesis of weakly cross-sectional dependent is rejected, showing that tobacco consumption of the provinces in Spain is correlated with tobacco consumption of other provinces.

Finally, an approximation is made by comparing price differentials between neighboring countries.

Results

Results of the spatial analysis and a comparison of prices between countries are presented in this section. Fig. 1 shows the results of the hot and cold spot analysis represented in four maps for years 2002, 2007, 2012, and 2017. These graphs include the presence of three significant clusters, two of which are cold spots (low per capita tobacco consumption in gray color) and one, a hot spot (high per capita tobacco consumption in black color).

The first cluster, in gray color, can be observed in the northwest area, mainly in the regions of Galicia. The presence of this cluster indicates that the per capita tobacco consumption in these regions was noticeably lower than that in the rest of the regions. Over time, it decreases to be null in the present, where there is no cluster formation. The second clusters, in dark color, are, in this case, areas of high per capita tobacco consumption (hot spot); they are located on the border with France, and these regions have a per capita tobacco consumption significantly higher than that of the rest of regions.

The third cluster, in gray color, which shows low per capita tobacco consumption (cold spot), appeared on the Gibraltar border and its surrounding areas for the first time in 2012 and remains there today. Being a cluster of low consumption tells us that the per capita tobacco consumption in these regions is substantially lower than that in the rest of regions. As price can play an important role in this situation, we analyze the price differential (measured in percentage of the Spanish price) between Spain and its bordering countries (Portugal and France) for the period 2004–2017. Data have been taken from a recent study.

These data show how the price differential between Spain and Portugal maintained throughout the analyzed years has always been low (between 0.82% and 22.22%), while the price differential between Spain and France has always been quite high (between 50.59% and 156.41%) with a decreasing trend in recent years. No tobacco price data have been found regarding Gibraltar, but a recent memorandum by the Government of Gibraltar indicates the need to harmonize the price differential with Spain by up to 32% because the current price differential is generating illicit tobacco trade in Spain.

These results, together with the cluster analysis, show clear evidence that the existence of high price differentials (Gibraltar greater than 32% and France greater than 50.59%) generate distortions in the per capita tobacco consumption, and this occurs not only in the border regions but also in regions close to these due to the existence of spillovers and the generation of clusters. On the other hand, maintaining a low price differential between countries does not generate distortion, as evidenced by the Portuguese case.

Discussion

Tobacco, which is strongly regulated by the government because of its negative effects on public health, has been a product susceptible to cross-border purchases between countries over the years. The novelty of this short communication is measuring the per capita tobacco consumption distortions through a spatial analysis.

By analyzing the consumption clusters that are generated in Spain, we find that, first, in 2002, the lowest per capita consumption of legal tobacco in Spain was concentrated in Galicia. This coastal region has been one of the most used by organizations dedicated to the smuggling of tobacco and drugs from America. However, in 2017, its behavior is similar to that of the Spanish average.

Second, we observe a cluster of high per capita consumption in the border area between Spain and France, which can be explained by price differential and the possible cross-border purchases of tobacco that distort the consumption in this area.

Third, a cluster of low consumption is detected in the area bordering Gibraltar, which can be explained by the price differential that can generate cross-border purchases, too. However, we do
not find clusters of consumption in the Portuguese border regions. This result can be explained by the tobacco low price differential between Spain and Portugal.

In sum, this short communication can serve as basis for governments to detect areas where the lack of price harmonization for tobacco products between countries can produce consumption distortions with health consequences. Future research may investigate the consequences of the lack of harmonization in health policies by focusing on the causal relationship between per capita tobacco consumption over time and variations in price differential with nearest countries to find an optimal price differential that does not generate distortions.

**Autor statements**

**Ethical approval**

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

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None declared.

**Competing interest**

None declared.

**References**