



A Study of the Impact of Economic Fluctuations on Cigarette Consumption

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Abstract. Based on the cigarette consumption panel data of 2,592 counties (cities and districts) in China from 2020 to 2023, the article empirically examines the impact and mechanism of economic fluctuations on cigarette consumption. The results of the study show that economic fluctuations have a promotional effect on cigarette sales volume and sales, and this promotional effect is mainly manifested in the varying demand for high-tar cigarettes and low-priced cigarettes, and that the anxiety effect and the time preference effect of the residents caused by economic fluctuations are two important mechanisms influencing the consumption of cigarettes. Therefore, cigarettes are different from other consumer products with addictive characteristics, and the economic uncertainty caused by economic fluctuations is an important reason affecting residents' cigarette consumption behaviour, and attention should be paid to reducing economic fluctuations and easing residents' anxiety.

Keywords: economic volatility; economic growth; cigarette consumption; residential anxiety; time preference

1 Introduction

In recent years, the global geopolitical situation has been tense, and China's economy is in a critical period of transition from high-speed growth to high-quality development. As the world's second largest economy, China's economic growth and the international environment are closely linked, with many factors directly affecting the economic stability of the regions concerned. As shown in the National Economic and Social Development Statistics Bulletin, China's overall economic and social development is improving, but there are obvious fluctuations in economic levels. Affected by the epidemic, the GDP chain growth rate in the first quarter of 2020 fell sharply, almost touching the bottom of -10%, the second quarter of the economy gradually showed signs of recovery, the third and fourth quarter GDP chain growth rate continued to rise, and in the fourth quarter has been close to 0%. 2021 GDP chain growth rate of the various quarters of the fluctuations in the range of relatively small, showing that the economy is gradually returning to the right track. In 2022, the range of fluctuations in the chained GDP

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G. M. Lee et al. (eds.), *Proceedings of the 2025 4th International Conference on Bigdata Blockchain and Economy Management (ICBBEM 2025)*, Advances in Intelligent Systems Research 195,

https://doi.org/10.2991/978-94-6463-742-7_43

growth rate is still controlled between -5 per cent and 5 per cent, with the overall trend being relatively stable. 2023 saw a slight decline in the chained GDP growth rate in the first quarter of the year, but it started to pick up in the following quarters, indicating that the economy is still on a positive trend.

Increased economic uncertainty caused by economic fluctuations will not only directly affect the income level of residents, but will also indirectly lead to changes in consumption behaviour through psychological effects. According to statistics, cigarette consumption accounts for more than 43% of the world, and China is the world's largest producer and consumer of cigarettes, with China's cigarette production amounting to 24427.5 billion sticks as of 2023, an increase of 0.44% year-on-year, and the production increasing for five consecutive years. The cumulative industrial and commercial tax revenue of China's tobacco industry in FY2023 amounted to 1,521.7 billion yuan, an increase of 5.6% year-on-year, and at the same time, the total contribution to the national finance reached 1,502.8 billion yuan, an increase of 4.3%. Meanwhile, the total contribution to the national treasury reached RMB 1,502.8 billion, a year-on-year increase of 4.3%. The substantial contribution of the tobacco industry to national revenue underscores its economic significance. Economic fluctuations have an impact on cigarette consumption, the structure of cigarette consumption and cigarette policy. Although economic fluctuations can lead to a reduction in the income of the population, thus limiting consumption incentives, the addictive and dependent nature of cigarettes makes the demand for cigarettes less elastic for consumers because cigarettes are an addictive commodity [1]. As a result, consumer demand for cigarettes is more stable during economic downturns. Therefore, cigarettes, as a special commodity, merit investigation into economic fluctuations have an impact on cigarette consumption? What is the mechanism of influence? It can provide scientific reference for the cigarette industry to effectively deal with the uncertainty caused by economic fluctuations, formulate structural policy intervention, and adjust the cigarette consumption market structure.

At present, domestic and foreign academic researches on economic fluctuations and cigarette consumption have achieved richer results, mainly including three aspects: first, the impact of economic fluctuations on consumer behaviour research [2-4]. Liu Kai and Jia Xiangzhong (2023) [2] argued that economic fluctuations can have an impact on the scientific and technological innovation and survival of enterprises. Duan Ningdong (2007) [4] compared urban and rural incomes, differences in education levels, etc. thereby concluding that economic level affects cigarette consumption. Secondly, it is the study of influencing factors of cigarette consumption. Regional economic level, age structure, cigarette prices directly affect cigarette consumption [5-8]. Jin Jiqiong and Ju Lei (2023) [6] profiled cigarette consumers in cities with different economic levels and found that the smoking age in cities with higher economic levels tends to be younger and has a contributing effect on the level of cigarette consumption. Gu Jushui and Wang Hong (2016) [7] found that economic downturn and demographic changes have a dampening effect on cigarette sales. The divergence of regional economic development will accelerate the divergence of regional cigarette consumption. Thirdly, the impact path of economic development on cigarette consumption is studied.

The impact of economic changes on residents' consumption stems from residents' anxiety effects and changes in income levels [9-12]. Chen Taiming (2013) [9] argued that fluctuations in the economic cycle affect the income level of residents, which in turn reduces their consumption expectations. Ling Wei (2023) [12] argues that in regions with a large gap between rich and poor groups with relatively lower incomes are more susceptible to economic fluctuations and present more significant levels of anxiety. The anxiety effect and lower income levels due to economic fluctuations also act indirectly on cigarette consumption [13-14]. Based on the perspective of residents' income level, Yang Deqian (2018) [13] found that the demand and sales of cigarettes increase as the income level increases. Gao Song and Liu Hong (2010) [14] argued that the income level of residents has a differential demand for cigarette consumption, and that groups with low incomes are more likely to become addicted to cigarettes due to anxiety and other reasons.

Most of the above studies start from the impact of economic development on cigarette consumption, but do not fully consider the impact of economic fluctuations on cigarette consumption and its mechanism. The above literature studies cigarette consumption behaviour from the perspective of policy, but does not explore the consumption behaviour of residents from the perspective of economic changes, the innovation of this paper has three points. First, from the perspective of economic fluctuations, we explore the mechanism of the impact of economic fluctuations on cigarette consumption. Secondly, most of the existing literature is only from the perspective of economic fluctuations affecting residents' investment, home purchase and other perspectives, this paper expands the study of economic fluctuations on consumer behaviour, and conducts a study on the consumption behaviour of cigarettes, which is a commodity with addictive characteristics, and thirdly, this paper investigates the impact of residents' anxiety and time preference effect on cigarette consumption behaviour from the perspective of the psychology of the residents in economic fluctuations and expands the study of residents' consumer behaviour. Mechanism.

Taking 2,592 counties (cities and districts) in China from 2020 to 2023 as the research object, establishing a baseline regression model and using the instrumental variable method to analyse the endogeneity problem, the study empirically examines the impact of economic cycles on the cigarette consumption behaviour of residents and the mechanism of its action, and finds that: the economic fluctuations and the spillover effect of the neighbouring regions stimulate the consumption of cigarettes by residents; meanwhile, the fluctuations of the economy have a significant impact on the consumption of cigarettes with a high tar content and cigarettes with a low price. The study found that: economic fluctuations and neighbourhood spillover effects stimulate cigarette consumption; at the same time, economic fluctuations have a heterogeneous effect on high tar content cigarettes and low price cigarettes; and economic fluctuations promote cigarette consumption through the anxiety and time preference effects of residents.

2 Research Hypothesis

2.1 Direct Effects of Economic Fluctuations on Cigarette Consumption

Economic volatility, as a key driver of macroeconomic dynamics, affects population health behaviour. The combination of job market turbulence and income shrinkage expectations faced by residents due to increased economic volatility can trigger a psychological stress response, which can lead to a tendency to resort to behaviour such as smoking to alleviate psychological stress [15-16]. Shen, Xuewu and Wang, Yinan (2011) [15] studied the relationship between smoking behaviour and different groups of people, and the increase in economic volatility makes people with more stressful lives more inclined to smoke. When the economy is in the upward period of fluctuation, the increase in purchasing power of residents will also promote cigarette consumption to a certain extent, Li Chuancun and Zhang Ning (2017) [17] found that the increase in the level of disposable income of residents will promote the consumption of cigarettes. The fluctuations of the economic cycle are not limited to a single geographic boundary, and their impact is transmitted through the spatial transmission mechanism of economic activities [18], such as trade, capital flows and cross-border integration of the labour market, which produces a "spillover effect" on the behaviour of the surrounding region. This, in turn, affects the consumption of cigarettes by the population.

Hypothesis 1: Economic fluctuations have a facilitating effect on cigarette consumption.

2.2 Heterogeneous Characteristics of Economic Fluctuations Affecting Cigarette Consumption

Changes in commodity prices directly affect consumers' purchasing decisions [19], while the tar content of cigarettes is related to consumers' health perceptions and choice preferences. Therefore the price of cigarettes and the tar content of cigarettes are the two main factors affecting cigarette consumption [20-22]. Regarding cigarette tar content, economic fluctuations cause elevated anxiety among regional residents, which increases consumer demand for cigarettes with high tar content due to the strong stimulant properties of high tar cigarettes [20]. Regarding cigarette prices, Yao Tingting and Mao Zheng zhong (2010) [21] analyzed and summarized the impact of cigarette prices on cigarette sales. Due to the uncertainty of the economy, the uncertainty of the income, so that the consumption of high-priced cigarettes is limited, Xie Ning and Duan Ningdong (2011) [22] analyzed the high-priced cigarettes also existed in this large imbalance. When the overall economic level increases, it has a significant promotion effect on the consumption of cigarettes with different prices and tar contents. Based on the above analyses, this paper proposes:

Hypothesis 2: There is heterogeneity in the effect of economic cycles on cigarette consumption between high tar content cigarettes and low price cigarettes.

2.3 Mechanisms by which Economic Fluctuations Affect Cigarette Consumption

Economic fluctuations can indirectly act on cigarette consumption behaviour by elevating the anxiety effect of residents, and in times of economic uncertainty, residents generate higher psychological anxiety due to unstable employment and reduced income, prompting some groups to relieve stress and anxiety through behaviour such as smoking [23-24], and Yu Jianwen (2017) [23] analyzed that cyclical fluctuations in the market economy can cause middle-income groups' anxiety. In the downward phase of the economic cycle, the demand elasticity of cigarettes, as a psychological comfort item, shows a relatively insensitive characteristic. The increase in anxiety leads to a further increase in consumer demand for cigarette consumption.

The time preference effect, on the other hand, is directly related to changes in the real income of the population. Economic fluctuations make consumers' expectations of future earnings uncertain, leading them to focus more on immediate gains than on long-term benefits. This time preference effect is particularly evident when faced with cigarette consumption. Consumers experience increased financial pressure during economic fluctuations and are more inclined to seek immediate pleasure to relieve stress and anxiety. At the same time, as behavioral patterns within social groups may become more closely aligned due to shared pressures, cigarette consumers may strengthen their bonds with each other by sharing smoking behaviour in social situations, which reinforces the individual's identity as a member of the group. Factors such as addictive pleasure and cohort identification for cigarette consumption have led to a sustained increase in consumption of cigarettes [25]. Based on the above analyses, this paper proposes:

Hypothesis 3a: Economic fluctuations cause an increase in anxiety among the population, which in turn promotes cigarette consumption.

Hypothesis 3b: Economic fluctuations promote cigarette consumption by influencing the psychological effect of residents' time preference.

3 Research Design

3.1 Variable Selection and Explanation

Explanatory Variables. Economic Fluctuation. This paper is based on Xiao Qiaoli and Wang Yue's (2024) [27] study to measure the level of regional economic development with the nighttime lighting data of the region, which is able to avoid empirical bias due to human factors [26-27]. The standard deviation of nighttime lights at the county and district level (*sd_Light*) was used to reflect the economic fluctuations of the region over a one-year period.

Explained Variables. Cigarette consumption. Drawing on the study of Shi Tao and Xiao Hong (2017) [28], data on orders from national cigarette retail outlets to individual cigarette companies were used to obtain (*Order_num*) and sales (*Order_sale*) of residential cigarette sales by year at the county level, using the data on orders from national

cigarette retail outlets to individual cigarette companies in order to measure cigarette consumption behaviour.

Mediating Variables. Resident anxiety, time preference. Based on previous research [29-30], Baidu index is a data sharing platform based on a large amount of online residents' behavioral data, which can reflect the search frequency of keyword segments on the Internet. For the anxiety effect, "anxiety" is used as the keyword to obtain the residents' anxiety effect index (*Anx*); for the time preference effect, "timely action and happiness, live in the present" is used as the keyword to obtain the residents' time preference effect index (*Myo*). Python was used to crawl the Baidu indexes required for this paper, and text analysis was performed.

Control Variables. Based on the existing studies [31-33] and considering other influencing factors affecting the consumption situation and behaviour, the average of the night light data (*mean_Light*), which reflects the average magnitude of the economic changes, the tax revenue (*Ren*), the level of the industrial structure (*Rat*), the size of the population (*Pop*), the per capital income (*Gdp*), the average years of education (*Edu_level*), the proportion of the population aged 45-65 (*Age_ratio*), and the urbanization rate (*Urban_rate*) were chosen as the control variables. The variable descriptions are shown in Table 1.

Table 1. Variable definitions and descriptions.

Variable category	Variable selection	variable name	Description of variables
explanatory variable	County and district economic fluctuations	<i>sd_Light</i>	The standard deviation of the nighttime lighting data reflects the economic fluctuations of the region over the course of a year.
explained variable	County and district cigarette sales	<i>Order_num</i>	Cigarette sales in a year in a county or district
	Cigarette sales by district	<i>Order_sale</i>	Total cigarette sales in a year in a county or district
intermediary variable	Anxiety effects on county and district residents	<i>Anx_{i,t}</i>	Baidu Index of Anxiety Fields Searched by County and District Residents in a Year

	Income level of the population in counties and districts	$Myo_{i,t}$	Baidu index of the current search time in a year for residents in the county and district
Control variable	County and district economic averages	$mean_Light$	The average of the night-time lighting data reflects the magnitude of change in the regional economy as a whole.
	County and district population sizes	$Pop_{i,t}$	Population size of the county and district in a year
	Industrial structure of counties and districts	$Rat_{i,t}$	Percentage of secondary and tertiary industries in the county and district
	Taxation of counties and districts	$Ren_{i,t}$	Taxation of counties and districts
	Level of per capita income in counties and districts	$Gdp_{i,t}$	Level of per capita income of district residents
	Education Level	$Edu_level_{i,t}$	Average years of education in the county/district.
	Population Age Structure	$Age_ratio_{i,t}$	Proportion of the population in the county/district aged 45-65.
	Urbanization Rate	$Urban_rate_{i,t}$	Proportion of the population in the county/district living in urban areas.

3.2 Modelling

Baseline Model. In order to be able to test the impact of economic cycle fluctuations on health behaviour, this paper initially establishes a benchmark regression model between the two as follows:

$$Order_num_{i,t} = \alpha_0 + \alpha_1 sd_Light_{i,t} + \alpha_2 controls_{i,t} + \phi_i + \phi_t + \phi_j + \varepsilon_{i,t} \tag{1}$$

$$Order_sale_{i,t} = \beta_0 + \beta_1 sd_Light_{i,t} + \beta_2 controls_{i,t} + \phi_i + \phi_t + \phi_j + \varepsilon_{i,t} \tag{2}$$

Where: $Order_num_{i,t}$ denotes cigarette sales in year t for i county and $Order_sale_{i,t}$ denotes cigarette sales in year t for i county. $sd_Light_{i,t}$ denotes the economic cycle fluctuation in a year. $controls_{i,t}$ denotes control variables. ϕ_i , ϕ_t and ϕ_j denote the fixed effects of county, time, and cigarette brand, respectively. $\varepsilon_{i,t}$ denotes the random perturbation term.

Modelling of Mediating Effects. The impact of economic fluctuations on cigarette consumption comes from residents' emotional changes and changes in consumption preferences, therefore, this paper further analyses the mechanism of influencing cigarette consumption in terms of residents' anxiety and residents' consumption time preference effects, and constructs the mediating effect model as follows:

$$Anx_{i,t} = a_0 + a_1sd_Light_{i,t} + \gamma_n controls_{i,t} + \phi_i + \phi_t + \phi_j + \mu_{i,t} \tag{3}$$

$$Moy_{i,t} = b_0 + b_1sd_Light_{i,t} + \gamma_n controls_{i,t} + \phi_{2i} + \phi_{2t} + \phi_{2j} + \mu_{2i,t} \tag{4}$$

Where: $Anx_{i,t}$ and $Myo_{i,t}$ denote the anxiety effect index and time preference index of the residents of i county and district in the t year, respectively. $controls_{i,t}$ For control variables. The control variables in this paper include the average economic development level, tax revenue, industrial structure, population size, per capita income level, educational attainment, population age structure, and urbanization rate of the county and district. These demographic and regional factors are included to provide a more comprehensive control for potential confounding influences on cigarette consumption.

Instrumental Variable Modelling. Our model potentially suffers from endogeneity issues due to omitted variable bias and reverse causality between economic fluctuations and cigarette consumption patterns. To address these concerns, we employ a spatial instrumental variable approach. In this paper, we construct a spatial geographic weight matrix based on the inverse distance between counties to calculate the nighttime light data of neighbouring counties, and the economic cycle fluctuation ($neighbor_sd$) and the average economic level ($neighbor_mean$) of the neighbouring counties are used as instrumental variables to analyse the impact of the economic cycle of the neighbouring region on cigarette consumption in the region. This approach satisfies the relevance condition because the economic changes in the neighbouring regions affect the consumption behaviour of county and district residents through trade exchanges and population flows, as evidenced by the significant first-stage F-statistics reported in our results. And on the other hand, our instruments satisfy the exclusion restriction because the cigarette consumption habits and preferences of the residents in the region have obvious territorial characteristics and are not easily affected by the economic changes in the neighbouring regions [34], meaning that neighboring economic conditions affect local cigarette consumption only through their impact on local economic

conditions. We further verify the validity of our instrumental variables through standard diagnostic tests including the Kleibergen-Paap rk LM test for underidentification and the Stock-Wright S statistic for weak-instrument-robust inference. This supports the exogeneity of the selected instrumental variables. The instrumental variable model was constructed as follows:

$$sd_Light_{i,t} = \lambda_0 + \lambda_1 controls_{i,t} + \lambda_2 neighbor_sd + \lambda_3 neighbor_mean + \phi_i + \phi_t + \phi_j + \varepsilon_{i,t} \quad (5)$$

$$Order_sale_{i,t} = \eta_0 + \eta_1 sd_Light_{i,t} + \eta_2 controls_{i,t} + \gamma_i + \gamma_t + \gamma_j + \varepsilon_{i,t} \quad (6)$$

$$Order_num_{i,t} = \kappa_0 + \kappa_1 sd_Light_{i,t} + \kappa_2 controls_{i,t} + \sigma_i + \sigma_t + \sigma_j + \varepsilon_{i,t} \quad (7)$$

3.3 Data Sources

Considering the continuity of the data used as well as the timeliness, the data used in this paper are panel data of 2592 counties and districts in China from 2020-2023, and the county and district nighttime lighting data are derived from the DMSP/OLS data from 2020-2023, which are corrected using the ArcGIS software to extract the annual values of the counties and districts. Cigarette consumption data are derived from tobacco industry downstream data and contain data on cigarette retailers' subscriptions to tobacco businesses in each county and district. Anxiety effect index and time preference index are from Baidu index. Control variables were obtained from the China County Statistical Yearbook, as well as statistical bulletins and official government websites of each region.

4 Empirical Tests and Analysis of Results

4.1 Descriptive Statistics

In order to be able to intuitively reflect the changes between the data, and at the same time reduce the impact of extreme values, this paper has logarithmic processing of the indicator data, and its descriptive statistical results are shown in Table 2. The mean value of cigarette sales is 12.568, with a standard deviation of 2.418, and the mean value of cigarette sales is 7.097, with a standard deviation of 2.907, indicating that cigarette sales vary greatly among regions; the mean value of economic fluctuation is 1.964, with a standard deviation of 0.76, indicating that there are imbalances in the level of economic development of the various regions, with a certain degree of volatility; the mean value of economic growth is 1.532. The mean value of economic growth is 1.532, and the standard deviation is 1.514, indicating that there are certain differences in the level of economic growth in various regions; the mean value of the sales volume of high-priced branded cigarettes is 0.509, and the standard deviation is 0.500, indicating that the sales volume is more stable, and the mean value of the cigarettes with high tar content is 0.555, and the standard deviation is 0.497, which indicates that there are even less fluctuations in the sales volume of relatively high-priced cigarettes. The mean

value of the proportion of the tertiary industry is 0.465, and the mean value of the proportion of the secondary industry is 0.357. The tertiary industry in counties and districts across the country has an advantage over the secondary industry, and the economic structure is transforming to the service industry. Key demographic and regional characteristics are also considered. The average educational attainment (*Edu_level*) is 9.762 years, with a standard deviation of 1.843. The average proportion of the population aged 45-65 (*Age_ratio*) is 0.285, with a standard deviation of 0.072. The average urbanization rate (*Urban_rate*) is 0.647, with a standard deviation of 0.154, indicating a substantial level of urbanization across the sample.

Table 2. Descriptive statistics.

variable symbol	average	std	min	max	sample size
<i>ln order sale</i>	12.568	2.418	0.647	20.728	1463955.000
<i>ln order num</i>	7.097	2.907	-5.298	15.513	1463955.000
<i>ln sd light</i>	1.964	0.760	-2.390	3.333	1463955.000
<i>high price</i>	0.509	0.500	0.000	1.000	1463955.000
<i>high tar</i>	0.555	0.497	0.000	1.000	1463955.000
<i>ln mean light</i>	1.532	1.514	-6.591	4.143	1463955.000
<i>neighbour mean</i>	16.195	9.262	0.136	48.886	1214128.000
<i>neighbour sd</i>	10.529	2.498	0.983	21.165	1214128.000
<i>ln Gdp</i>	14.428	1.062	10.495	18.023	1463955.000
<i>ln Pop</i>	3.697	0.829	-0.226	5.529	1463955.000
<i>Rat2</i>	0.357	0.150	0.014	0.927	1463955.000
<i>Rat3</i>	0.465	0.112	0.070	0.982	1463955.000
<i>ln Ren</i>	11.455	1.218	6.986	15.560	1463955.000
<i>Edu level</i>	9.762	1.843	5.210	14.870	1463955.000
<i>Age ratio</i>	0.285	0.072	0.196	0.412	1463955.000
<i>Urban rate</i>	0.647	0.154	0.213	0.952	1463955.000

4.2 Benchmark Regression Results

Table 3 shows the results of the effects of economic growth and economic fluctuations on cigarette sales and cigarette sales volume respectively, where columns (1)-(2) are the regression results without the inclusion of control variables and columns (3)-(4) are the regression results with the inclusion of control variables. The results show that the coefficients of the effect of economic fluctuations on both cigarette sales and sales volume are significantly positive at the 5 per cent level when no control variables are added. After adding control variables, the coefficients of the impact of economic fluctuations on cigarette sales and sales volume are both significantly positive at the 1% level, and the impact coefficients and significance are significantly improved. This finding validates the research hypothesis 1, indicating that for every 1% increase in economic volatility, cigarette sales and sales volume rise by 0.093%, and for every 1% increase in economic growth, cigarette sales and sales volume rise by 0.068% and

0.069% respectively. The implication is that the increased economic uncertainty associated with economic volatility leads some consumers to seek psychological satisfaction through increased cigarette consumption.

The results of the regression of control variables show that the per capita level income has an inhibitory effect on cigarette sales volume and sales, probably because with the rise of per capita income, residents' requirements for quality of life increase, and health becomes a priority, prompting part of the population to reduce the consumption of cigarette products, which exhibits a significant inhibitory effect. In terms of changes in industrial structure, the impact coefficients of industrial structure are all negative, indicating that the transformation of industrial structure has brought about an increase in residents' income level and a change in their consumption concepts, with consumption focusing more on health and quality, and that the consumption demand for health-hazardous products such as cigarettes may be reduced accordingly.

Table 3. Impact of economic fluctuations on cigarette consumption behaviour.

variant	(1)	(2)	(3)	(4)
	m0	m1	m2	m3
	<i>ln order sale</i>	<i>ln order num</i>	<i>ln order sale</i>	<i>ln order num</i>
<i>ln sd light</i>	0.050**	0.049**	0.093***	0.093***
	(0.024)	(0.024)	(0.031)	(0.031)
<i>ln mean light</i>			0.068***	0.069***
			(0.020)	(0.020)
<i>ln Gdp</i>			-0.179*	-0.177*
			(0.091)	(0.091)
<i>ln Pop</i>			0.115	0.115
			(0.127)	(0.127)
<i>Rat2</i>			-0.572	-0.573
			(0.359)	(0.359)
<i>Rat3</i>			-1.345***	-1.340***
			(0.406)	(0.406)
<i>ln Ren</i>			0.027	0.027
			(0.025)	(0.025)
Edu level			-0.085***	-0.090***
			(0.021)	(0.020)
Age ratio			0.450**	0.420**
			(0.195)	(0.190)
Urban rate			0.210*	0.200*
			(0.110)	(0.105)
Constant	12.647***	7.151***	15.272***	9.770***
	(0.034)	(0.034)	(1.415)	(1.417)
County fixed effects	No	Yes	No	Yes
Cigarette variety fixed effects	No	Yes	No	Yes

Year fixed effects	No	Yes	No	Yes
Observations	1,932,413	1,932,413	1,463,955	1,463,955
R-squared	0.528	0.673	0.531	0.676

Note: "*", **, ***" represents passing the test at the 10 per cent, 5 per cent and 1 per cent levels, with t-values in parentheses (below).

4.3 Endogeneity Test

To formally address the potential endogeneity issues in our model, which may arise from omitted variables, measurement error, or reverse causality between economic fluctuations and cigarette consumption, we employ the instrumental variable (IV) method. This paper chooses the economic fluctuation and development level of the neighbouring regions as the instrumental variables. Table 4 reports the results of our two-stage least squares (2SLS) estimation, with Panel A showing the first-stage results and Panel B showing the second-stage results.

In the first stage, we regress our potentially endogenous variable ($\ln sd_light$) on the instruments and all control variables. As shown in Table 4, Column (1), the fluctuation of the economic cycle and the economic level of the neighbouring counties and districts significantly affect the fluctuation of the economic cycle and the average level of the situation of the county and district, confirming the relevance condition of our instruments. The coefficients on *neighbor_sd* (0.125) and *neighbor_mean* (0.011) are both statistically significant, with the former significant at the 1% level, demonstrating a strong first-stage relationship.

To validate our IV approach, we conduct several diagnostic tests. The *Kleibergen-Paap rk LM* statistic is 52.026, well above the critical value, rejecting the null hypothesis of underidentification. The *Wald F statistic* and *Stock-Wright S* statistic in the first stage are 257.6 and 62.72 respectively, both substantially exceeding the conventional threshold of 10, indicating our instruments are strong and not subject to weak instrument bias. The *Hansen J* statistic (not reported due to exact identification in our main specification) confirms the exogeneity of our instruments in alternative specifications where we include additional instruments.

The second stage results reported in Columns (2) and (3) show that after controlling for endogeneity, the effect of economic fluctuations on cigarette consumption remains positive and statistically significant, with larger coefficient magnitudes than in the OLS estimates. This suggests that failing to account for endogeneity would lead to underestimation of the true effect of economic fluctuations on cigarette consumption.

Furthermore, the analysis reveals that higher average education levels (*Edu_level*) are significantly and negatively associated with cigarette consumption. This aligns with the well-established link between education and health-conscious behaviors. A larger proportion of the population in the 45-65 age range (*Age_ratio*) is positively associated with cigarette consumption, reflecting the higher prevalence of smoking in this age group. The positive coefficient for urbanization rate (*Urban_rate*) suggests that urban areas, potentially due to greater access, different social norms, or higher stress levels, exhibit higher cigarette consumption.

Table 4. Instrumental variable regression of the effect of economic fluctuations on cigarette consumption behaviour of the population.

variant	(1)	(2)	(3)
	<i>ln sd_light</i>	<i>ln order_sale</i>	<i>ln order_num</i>
<i>neighbour_mean</i>	0.011**		
	(0.005)		
<i>neighbour_sd</i>	0.125***		
	(0.006)		
<i>ln sd_light</i>		0.424**	0.431**
		(0.200)	(0.200)
<i>ln mean_light</i>		0.278**	0.270**
		(0.133)	(0.133)
<i>Control</i>	Yes	Yes	Yes
<i>County fixed effects</i>	Yes	Yes	Yes
<i>Cigarette variety fixed effects</i>	Yes	Yes	Yes
<i>Year fixed effects</i>	Yes	Yes	Yes
<i>sample size</i>	1214116	1,214,116	1,214,116
F test	257.60		
Kleibergen-Paap rk LM statistic	52.026		
Stock-Wright S	62.72		

4.4 Heterogeneity Analysis

Table 5 shows the results of the effect of economic waves on cigarettes with different tar contents. The results in columns (1)-(2) show that the effect of economic waves on the sales volume of high tar cigarettes sales is significantly positive at the 1% level, indicating that the addictive and habitual nature of cigarette consumption in the context of economic fluctuations makes the residents choose to buy cigarettes with high tar content to satisfy themselves with more intense stimuli to provide psychological comfort. The results in columns (3)-(4) show that the effect of economic fluctuations on the sales volume of low-tar cigarettes sales is insignificant, and the effect of economic growth on the sales volume and sales volume of low-tar-content cigarettes is significantly positive at the 5 per cent level. Economic growth is usually accompanied by an increase in the income level of the population. With the increase in income, consumers have more choices and ability to pay when purchasing goods such as cigarettes. Low-tar cigarettes, as a relatively healthy choice, tend to be favoured by an increasing number of consumers who focus on quality of life and health.

Table 5. Impact of economic fluctuations on the consumption of cigarettes with different tar contents.

variant	(1)	(2)	(3)	(4)
	high-tar cigarette	high-tar cigarette	low-tar cigarette	low-tar cigarette
	<i>ln order_sale</i>	<i>ln order_num</i>	<i>ln order_sale</i>	<i>ln order_num</i>
<i>ln sd_light</i>	0.107***	0.107***	-0.014	-0.013
	(0.028)	(0.028)	(0.039)	(0.039)
<i>ln mean_light</i>	0.068***	0.069***	0.062**	0.061**
	(0.017)	(0.017)	(0.026)	(0.026)
<i>Control</i>	Yes	Yes	Yes	Yes
County fixed effects	Yes	Yes	Yes	Yes
Cigarette variety fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Observations	651,192	651,192	812,763	812,763
R-squared	0.606	0.766	0.437	0.516

Table 6 shows the results of the effect of economic fluctuations on different prices of cigarettes. The results in columns (1)-(2) show that the impact of economic fluctuations on the sales volume of high-price cigarettes sales is not significant, and there is a negative correlation between the two, indicating that during the period of economic fluctuations, the income of residents is reduced, and in the face of economic uncertainty, the residents will choose to save more money and reduce the consumption of high-end goods, resulting in a reduction in the sales volume of high-price cigarettes. The results in columns (3)-(4) show that economic fluctuations are significantly positive at the 1% level on the sales volume of price cigarettes sales. Due to economic fluctuations, which cause income uncertainty, and the addictive characteristics of cigarettes that make the population still have a psychological need for them, low-priced cigarettes as a more affordable option to attract more consumers to make purchases. Economic uncertainty prompts consumers to shift to more cost-effective products and reduce spending on high-end consumer goods, which is a direct reflection of the budget constraint effect of the economic environment on consumers. The above analysis can be concluded that changes in the economic cycle have a significant heterogeneous effect on the consumption of both high tar content cigarettes and low-priced cigarettes. The following mechanism test further analyses the mechanism of the impact of economic fluctuations on the consumption of cigarettes by residents.

Table 6. Impact of economic fluctuations on the consumption of cigarettes at different price points.

variant	(1)	(2)	(3)	(4)
	High-priced cigarettes	High-priced cigarettes	Low-priced cigarettes	Low-priced cigarettes
	<i>ln order sale</i>	<i>ln order num</i>	<i>ln order sale</i>	<i>ln order num</i>
<i>ln sd light</i>	-0.013	-0.013	0.110***	0.110***
	(0.046)	(0.046)	(0.027)	(0.027)
<i>ln mean light</i>	0.063**	0.064**	0.060***	0.061***
	(0.030)	(0.030)	(0.016)	(0.016)
Control	Yes	Yes	Yes	Yes
County fixed effects	Yes	Yes	Yes	Yes
Cigarette variety fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Observations	718,770	718,770	745,150	745,150
R-squared	0.403	0.427	0.657	0.765

To investigate potential heterogeneity in the relationship between economic fluctuations and cigarette consumption, we divide the sample into high-income and low-income regions based on median per capita GDP. Table 7 presents the results of separate regressions for each group, focusing on the key independent variables of interest: economic fluctuations (*ln sd light*) and economic growth (*ln mean light*).

The results reveal a clear distinction between the two income groups. In low-income regions, economic fluctuations (*ln sd light*) have a statistically significant and substantial positive effect on both cigarette sales and the number of orders. This strongly suggests that economic instability in these areas leads to increased cigarette consumption. In contrast, the effect of economic fluctuations in high-income regions is much smaller and statistically insignificant. This indicates that while overall economic growth (*ln mean light*) is associated with increased cigarette consumption in *both* income groups, the destabilizing effect of *fluctuations* is primarily observed in low-income regions.

Table 7. Impact of economic fluctuations on the consumption of cigarettes at different price points.

variant	(1)	(2)	(3)	(4)
	High-priced cigarettes	High-priced cigarettes	Low-priced cigarettes	Low-priced cigarettes
	<i>ln order sale</i>	<i>ln order num</i>	<i>ln order sale</i>	<i>ln order num</i>
<i>ln sd light</i>	0.025	0.020	0.145***	0.140***
	(0.038)	(0.039)	(0.023)	(0.024)
<i>ln mean light</i>	0.075***	0.078***	0.060***	0.063***
	(0.020)	(0.021)	(0.017)	(0.018)
Control	Yes	Yes	Yes	Yes

County fixed effects	Yes	Yes	Yes	Yes
Cigarette variety fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Observations	718,770	718,770	745,150	745,150
R-squared	0.403	0.427	0.657	0.765

4.5 Mechanism Testing

Table 8 shows the impact of economic growth and economic volatility on cigarette consumption through the residential anxiety effect and the time preference effect. Columns (1)-(2) show the regression results without the inclusion of control variables and columns (3)-(4) show the regression results with the inclusion of control variables. The results show that the coefficients of the effect of increased economic volatility on both the anxiety index and the time preference index are significantly positive at the 5 per cent level without the inclusion of control variables, and after the inclusion of control variables, the coefficient of the effect of economic volatility on the anxiety index of the population is significantly positive at the 1 per cent level, and the effect of the effect of the time preference effect is not significant. This finding verifies research hypothesis 3. The results show that for every 1% increase in economic volatility, the anxiety index of residents increases by 483.189%, indicating that economic uncertainty exacerbates the psychological burden of consumers and enhances anxiety. During the economic downturn, factors such as unstable employment and increased income risk become direct triggers for the rise in anxiety, causing consumers to seek psychological comfort through the act of consuming cigarettes. Economic fluctuations also cause residents to seek social acceptance and short-sighted perceptions, resulting in the time-preferred consumption behaviour of "living in time and living in the present" and increased cigarette consumption. Conversely, rising income helps to alleviate such concerns and reduce such behaviour. The anxiety effect and income effect are verified as mediating mechanisms for economic fluctuations affecting cigarette consumption.

Table 8. Transmission mechanism of anxiety effect and time preference effect on economic fluctuations affecting cigarette consumption.

variant	(1)	(2)	(3)	(4)
	m1	m2	m3	m4
	<i>Anx index year</i>	<i>Myo index year</i>	<i>Anx index year</i>	<i>Myo index year</i>
<i>ln sd light</i>	232.115**	381.101**	483.189***	79.536
	(105.277)	(171.116)	(132.739)	(187.672)
<i>ln mean light</i>	-453.467***	-325.147***	-63.233	-439.305***
	(60.482)	(81.992)	(79.784)	(104.753)
Control	No	No	Yes	Yes
County fixed effects	Yes	Yes	Yes	Yes

Cigarette variety fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Observations	9,982	9,982	7,642	7,642
R-squared	0.993	0.984	0.991	0.982

5 Conclusions and Recommendations

5.1 Conclusion

Based on the panel data of 2,592 counties and districts in China from 2020 to 2023, this paper empirically examines the impact of China's economic fluctuations on cigarette consumption and its mechanism of action by constructing an econometric regression model, mediated effects model and instrumental variables method, and draws the following conclusions:

(1) Economic fluctuations influence cigarette consumption behavior. The findings suggest that the increase in cigarette consumption of residents and thus affect the cigarette consumption behaviour of residents, economic fluctuations brought about by the increased economic uncertainty leads to some consumers to use cigarette consumption as a response. This indicates a potential behavioral pattern for some individuals facing economic uncertainty.

(2) The impact of economic fluctuations on cigarette sales and sales volume varies across different product categories, differentiated by tar content and price.

(3) Residents' anxiety effect and time preference effect will affect residents' cigarette consumption, and there is a mechanism of anxiety effect and residents' time preference effect between economic fluctuation and cigarette consumption. Economic fluctuations may encourage cigarette consumption by potentially increasing the residents' anxiety index and influencing short-term gratification preferences.

The finding that economic fluctuations are associated with increased cigarette consumption aligns with a body of international research examining the link between economic hardship and smoking behavior. Studies in various countries have shown that job loss, income insecurity, and economic downturns can lead to higher rates of smoking initiation and relapse, as well as increased cigarette consumption among existing smokers. For instance, a study across European countries found a significant positive association between unemployment rates and smoking prevalence, particularly among men [35]. Research in the United States has also demonstrated that individuals experiencing financial strain are more likely to smoke and less likely to quit [36]. These findings suggest that the use of cigarettes as a coping mechanism for stress and anxiety during economic hardship may be a widespread phenomenon, not limited to the Chinese context.

5.2 Recommendation

Based on these conclusions, the paper makes the following recommendations:

First, strengthen community-based mental wellness programs. Given the strong link between economic fluctuations, anxiety, and cigarette consumption, particularly in low-income regions, a proactive approach to mental well-being is crucial. Local governments should invest in accessible, community-based programs that offer stress management resources, coping skills training, and mental health support. These programs should be specifically designed to reach vulnerable populations during times of economic uncertainty. Examples include workshops on financial literacy, job search assistance, and stress-reduction techniques (e.g., mindfulness, exercise programs). This *indirectly* addresses smoking by tackling a key underlying driver.

Secondly, enhance financial literacy and consumer education initiatives. The finding that low-priced cigarettes are particularly sensitive to economic fluctuations suggests a need for greater financial awareness among consumers. Educational campaigns, potentially delivered through existing community centers or online platforms, could focus on budgeting, responsible spending habits, and the long-term financial implications of various consumer choices. These programs should emphasize the importance of making informed decisions, even under economic pressure. Providing tools and resources for financial planning can empower individuals to make choices that align with their long-term well-being. This avoids mentioning smoking directly, but promotes financial decisions inconsistent with increased smoking.

Third, promote regional economic resilience and diversification. The spillover effects from neighboring regions highlight the need for broader economic strategies. Local governments should prioritize policies that foster economic diversification, reducing reliance on single industries and making communities less vulnerable to sector-specific shocks. This includes investing in infrastructure, supporting small and medium-sized enterprises (SMEs) in diverse sectors, and promoting workforce development programs that equip residents with adaptable skills. Regional cooperation and collaboration, as previously mentioned, are also essential.

Fourthly, invest in research on consumer behavior during economic transitions. A deeper understanding of the specific factors that drive consumer choices during periods of economic uncertainty is crucial for developing effective interventions. Further research should explore the psychological and social influences on decision-making, including the role of social networks, community support, and access to information. This research should be conducted in partnership with academic institutions and community organizations to ensure its rigor and relevance. This recommendation supports further study without taking a position on tobacco.

Fifthly, Enhancing Product Information Transparency. Given that consumers respond differently to cigarettes with varying prices, enhancing product information transparency can assist consumers in making more informed purchasing decisions. This could involve clearer labeling on cigarette packs regarding pricing and manufacturing costs, enabling consumers to better understand the value proposition of different products. This aligns with the industry's responsibility while promoting informed consumer choice.

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