Estimating the impact of COVID-19 on changes in volume sales of cigars, smokeless tobacco products, pipe, and roll-your-own tobacco in the United States

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ABSTRACT

INTRODUCTION: We examined the potential impact of COVID-19 on trends in volume sales of non-cigarette combustible and smokeless tobacco products in the U.S.

METHODS: We analyzed monthly national sales for cigars, smokeless tobacco, pipe, and roll-your-own tobacco during June 2019-June 2021. Data were from the U.S Department of the Treasury. Interrupted time series were used to measure associations of the COVID-19 "shock" (taken as June 2020 or 6 months after the first diagnosis of COVID-19 in the US) and volume sales. Negative binomial regression was used to evaluate associations between volume sales and changes in community mobility.

RESULTS: Within interrupted time series analysis, the shock of the COVID-19 pandemic was associated with an initial increase in the number of little cigars sold by 11.43 million sticks ($p<0.01$), with no significant sustained change in trend. The COVID-19 shock was also associated with an initial increase in large cigar volume sales by 59.02 million sticks, followed by a subsequent decrease by 32.57 million sticks per month ($p=0.005$). Every 10% reduction in mobility to retail stores was significantly associated with reduced volume sales of little cigars (IRR = 0.84, 95% CI, 0.71 to 0.98) and large cigars (IRR = 0.92, 95% CI, 0.88 to 0.96). Other findings were statistically non-significant.

CONCLUSION: COVID-19 was associated with increased volume sales for cigars and there was a significant association between reduced mobility to points of sale and reduced cigar volume sales. Intensified efforts are needed to prioritize evidence-based tobacco prevention and control efforts amidst the pandemic.

Implications

- At the six-month mark following the start of the COVID-19 pandemic in the US, we found that the shock of the COVID-19 pandemic was associated with a statistically significant initial increase in the number of little and large cigars sold nationwide.
- These COVID-19 related trends may have momentarily reversed the long-term declines seen in cigar sales prior to the pandemic.
- Intensified implementation of evidence-based tobacco control and prevention measures amidst the COVID-19 pandemic may help reduce aggregate tobacco consumption.

BACKGROUND

COVID-19 is one of the longest, most sustained, and most destructive public health emergencies in recent times, the health and economic effects of which are far from over. It is conceivable that COVID-19 could have influenced tobacco use behaviors through direct or indirect mechanisms, including changes in initiation, cessation, and relapse.[1–4] Some tobacco retailers may have been forced to close their shops because of disruptions in the supply chain.[4] Furthermore, many US states implemented lockdowns at various points which restricted movements, including to tobacco points of sale.[5] The shock of COVID-19, the economic fallout from job losses, and the psychosocial stress, all may have contributed to increased smoking as a coping mechanism.[6] Yet, at the same time, as the science became clearer on the association between smoking and COVID-19, that may have served as a deterrent against smoking. [7–10]

South Africa, India, and Botswana are countries that imposed bans on the sale and use of tobacco at some point during the COVID-19 pandemic as part of their broad prevention and control efforts.[11–13] For example, South Africa's tobacco ban—which lasted 5.5 months—was implemented under the rationale that respiratory conditions attributable to smoking could predispose or exacerbate COVID-19 outcomes.[14] Regardless of the reasoning, such bans potentially had direct impact on sales and consumption during and even after the lifting of such restrictions, especially if they contributed to some users quitting because of lack of access, or if the extended restriction forced some small vendors out of business because of cash flow problems. One South African study estimated that 41% of smokers in the country made a quit attempt during the tobacco ban of which 38% reported they were

successful, and 88% of those who were successful reporting they intended not to start again, putting the percentage of smokers who potentially quit because of the ban at 13.7% of all smokers.[15] Negative consequences of the ban have also been reported, including lost revenues for the government and increase in illicit tobacco trade.[15]

No study in the US has examined the potential impact of COVID-19 on long-term consumption of non-cigarette tobacco products, and that is the aim of this paper. Previous research examined the impact of COVID-19 on U.S. cigarette consumption patterns,[16] but given differences in accessibility, pricing, and patterns of use between cigarettes and other tobacco products, research on the impact on non-cigarette products is warranted. Information on tobacco sales trends during COVID-19 is important for many reasons. Data on trends in taxable removals (i.e., actual sales) can help tax agencies such as the Treasury estimate changes in earned or projected revenues. Given the associations between smoking and COVID-19 morbidity and mortality,[7–10] it is of clinical and policy relevance to examine the ripple effect of policies such as government mandated shut-downs, on tobacco consumption patterns even though their primary purpose was to reduce onward transmission. Furthermore, a better understanding of which specific tobacco products from the plethora of unequally taxed/regulated substitute products experienced the most dramatic changes in volume sales during a time of economic austerity can provide useful insights to policy makers to help reduce price minimizing strategies by smokers.[17,18] There is also a need to understand changes in mobility to retail stores during the COVID-19 pandemic. From a quasi-experimental context, this evaluates the potential impact of supply-reduction strategies that have been proposed in certain tobacco endgame strategies [19].

We examined monthly sales data for little and large cigars, smokeless tobacco products, pipe, and roll-your-own (RYO) tobacco for the period June 2019 to June 2021 to explore trends in tobacco consumption, as well as to examine the associations between the shock of the COVID-19 pandemic and tobacco consumption trends. Two key questions were posed: (1) did the initial shock of the COVID-19 pandemic have a significant impact on trends in consumption of non-cigarette combustible and smokeless tobacco products? (2) During the pandemic, what was the association between reduced mobility to different public places and consumption of the various non-cigarette combustible and smokeless tobacco products?

METHODS

Data sources

As our analysis required time series data – observations from different points in time spread out across regular intervals, we used monthly volume sales as this was the only available data source fit for purpose. Monthly sales of tobacco products in the U.S. overall during June 2019 to June 2021 were obtained from the U.S. Department of the Treasury.[20] The tobacco products captured were little cigars, large cigars, moist snuff, chewing tobacco, pipes, and RYO tobacco. Sales were reported in sticks for cigars and in pounds for pipe, chewing tobacco, RYO, and snuff.

We linked data on monthly tobacco sales with COVID-19 Community Mobility Reports for the U.S. overall during March 2020 to June 2021 (data not available for earlier periods).[21]

This dataset contained records of transportation trends in the country compiled by Google using anonymized information from cell phone users who turned on their "Location History" setting. The data shows how visitors to (or time spent in) categorized places change compared to the baseline period, where the baseline was computed with data from January 3 to February 6, 2020. Because of differences in units of time between tobacco sales data (monthly) vs Google mobility data (daily), we generated monthly summary estimates of the Google mobility data by using the minima for each month (i.e., lowest mobility recorded).

Measures

Volume sales of non-cigarette combustible and smokeless tobacco products

Because of relatively small numbers for chewing tobacco, the number of pounds of moist snuff and chewing tobacco sold were summed together as “smokeless tobacco”. Volume sales were divided by 1 million and expressed as millions of sticks or pounds sold.

Mobility and other variables of interest

We were interested in exploring how changes in mobility to potential points of sale were associated with changes in tobacco volume sales. We therefore focused on the following three environments captured within the Google Mobility data because of their potential role as points of sale (or near points of sale): *Retail and recreation*, *Grocery and pharmacy*, and *Transit stations*. *Retail and recreation* refer to areas with restaurants, cafes, shopping centers, theme parks, museums, libraries, and movie theaters. *Grocery and pharmacy* refer to areas with grocery markets, food warehouses, farmers markets, specialty food shops,

drug stores, and pharmacies. *Transit stations* refer to areas with public transport hubs such as bus, cab, or train stations.

We considered the month of June 2020 (6 months after the first diagnosed case in the US) as "month 0" in measuring the "shock impact" of COVID-19 and its potential impact on tobacco use behaviors. The choice of this date factored in the following: (1) After the first COVID-19 cases in the U.S., there was about 6 months of COVID-19 denial in the country, including from the highest levels of the U.S. government.[22] (2) June also marked rising infection in almost half of the country, with the daily number of new cases surging to then unprecedented levels.[22] The scale, speed, and trajectory of the pandemic, coupled with the onslaught of emotional and economic challenges from a new way of life (working from home, home schooling, economic downturn, among other challenges), were at a tipping point enough to cause a "shock" to the collective consciousness. (3) By this time, many states had issued or were issuing government-mandated shutdowns to combat the rising number of cases.[5] Between March and April 2020, 43 governors had issued orders directing residents to stay at home and for "nonessential" businesses to close.[5] We assumed it would take a few weeks for these government-mandated lockdowns to begin to have a real pinch on people's mental and psychological wellbeing, bringing us to June as our "month 0". A Based on this specified "month 0", we created a continuous indicator for duration (i.e., the number of months between month 0 and an index date); we also created a binary indicator for time before or after "month 0".

Methodologically, the estimations of immediate impact and the changes in trend are highly sensitive to the choice of cut-off point.[23] To account for this uncertainty, we performed sensitivity analysis where we tested each of the six months during January to June of 2020 as a cut-off.

Given the potential impact of the economic situation as a confounder of the relationship between the COVID-19 shock and tobacco use patterns (e.g., switching to cheaper-priced products), we assessed data on monthly unemployment rates as an adjustment variable.[24]

Statistical analyses

Trend in volume sales of non-cigarette combustible and smokeless tobacco products

To test the statistical significance of changes in volume sales trends during the study period, join point regression analyses were performed using NCI's Join point 4.8.0 software. Annual percentage changes (APCs) with 95% confidence intervals were computed for each trend line segment and average annual percentage changes (AAPCs) were computed to summarize the temporal trends over the entire period. Statistical testing for the number of join points (inflection points) were performed using a Monte Carlo Permutation method and began with the minimum number of join points (i.e., 0 which corresponds to a straight line) and then testing whether more join points were statistically significant and must be added to the model.

Impact of the "COVID-19 shock" on sales of non-cigarette combustible and smokeless tobacco products

Using interrupted time series (ITS) regression models, we measured the associations between the shock of COVID-19 and US volume sales of little and large cigars, smokeless tobacco products, pipe, and RYO tobacco. ITS models work by specifying trends in an outcome before vs after a specified date (or exposure) and measuring a) the vertical distance between proximal ends of both trends, and b) the difference between gradients of both trends (i.e., immediate, and sustained impacts of an exposure). The null hypothesis was one of no association between the shock of COVID-19 and tobacco volume sales. This hypothesis was empirically tested using an ITS model with the following specification:[25]

$$Y_t = \alpha + \beta_1*(\text{month}_t - \text{month}_0) + \beta_2*(\text{month}_t - \text{month}_0)*(\text{month}_t >= \text{month}_0) + \beta_3*(\text{month}_t >= \text{month}_0) + \varepsilon_t$$

Where Y_t represents monthly changes in tobacco volume sale, α the constant term, β_1 the outcome trend in the pre-exposure period, β_2 the sustained impact of the exposure, β_3 the immediate impact of the exposure (i.e., COVID-19 shock), and ε_t the error term at time t. To prevent model misspecification, ITS strategy was implemented with both linear and quadratic time trends. We used an alpha of 0.05 as the threshold for statistical significance.

Association between mobility and volume sales of non-cigarette combustible and smokeless tobacco products

We used a negative binomial regression model to evaluate volume sales as a function of mobility categories during March 2019 and June 2021, adjusting for duration and unemployment rate. Our null hypothesis was that there was no association between volume sales of tobacco and any mobility category.

RESULTS

Monthly trends in sales of non-cigarette combustible and smokeless tobacco products

Cigars saw an increase in volume sales during the pandemic (Figure 1). The hitherto declining trends in volume sales for little cigars pre-pandemic (9.94 to 3.36 million sticks between June 2019 to November 2019), reversed and started increasing from December 2019 (7.20 million sticks), rising to reach 24.74 million sticks in June 2021. Join point analysis of little cigar volume sales trends confirmed a statistically significant overall increase in the number of little cigars sold nationwide during the entire study period from June 2019 to June 2021 (AAPC =4.8; 95% CI, 2.5 to 7.2, $p < 0.001$). Within join point analysis, volume sales for large cigars declined significantly between June 2019 (400.75 million sticks) and March 2020 (349.88 million sticks, APC = -2.7, 95% CI, -4.4 to -1.1), followed by a brief increase between March and June of 2020, with sales peaking at 435.75 million sticks in June 2020. Sales then declined significantly between June 2020 and January 2021 (APC = -3.1, 95% CI, -6.1 to -0.1), after which they plateaued for the rest of the study period with 405.03 million sticks sold in June 2021.

During June 2019-June 2021, modest but statistically significant declines were noted for both pipe tobacco (from 2.46 to 2.09 million pounds, AAPC = -0.7, 95% CI, -1.6 to -0.7) and RYO tobacco (from 0.13 to 0.11 million pounds, AAPC = -1.7, 95% CI, -2.8 to -0.6) (p-trends <0.05). Between June 2019 and June 2021, no statistically significant changes occurred in trends for volume sales of smokeless tobacco products (from 10.40 to 11.98 million pounds, p-trend = 0.70) (Supplemental Figure 1).

Associations between COVID-19 "shock" and volume sales of non-cigarette combustible and smokeless tobacco products

Within interrupted time series analysis, the shock of the COVID-19 reality (taken as 6 months into the COVID-19 pandemic) was associated with an initial increase in the number of little cigars consumed by 11.43 million sticks ($p < 0.01$), with no significant sustained change in trend thereafter (Table 1). The COVID-19 shock also resulted in an initial increase in volume sales of large cigars, to the amount of 59.02 million sticks followed by a statistically significant sustained decrease in monthly large cigar sales of 32.57 million sticks per month (p=0.005). Figures 2 and 3 show the pre- and post- trend for little and large cigars respectively. For smokeless tobacco, the COVID-19 shock was not associated with any statistically significant initial change (p=0.308) but was associated with a subsequent reduction in monthly sales to the amount of 0.95 million pounds per month (p=0.031). No significant changes in pipe and RYO tobacco volume sales attributable to the COVID-19 shock were noted.

Within sensitivity analysis examining different cut-off points for the "COVID-19 shock", we observed a first initial impact that was statistically significant in April 2020 for little cigars (initial increase of 6.19 million sticks, p=0.022) (Supplemental Table 1), just about half compared to the June 2020 cut-off (11.43 million sticks). Despite an initial significant impact for little cigars being seen only in April 2020 for the first time, a significant sustained impact was seen all the way back in January 2020 (sustained increase of 3.72 million per month), in February 2020 (sustained increase of 4.08 million sticks per month), in March 2020 (sustained increase of 4.16 million sticks per month), and in April 2020 (sustained increase of 3.77 million sticks per month). For large cigars, sensitivity analysis revealed that the first significant initial impact was in May 2020 (initial increase of 74.69 million sticks attributable to COVID-19, p=0.004). No significant sustained change in large cigar volume sales was seen in the months preceding June 2020.

Changes in community mobility to different destinations early in the pandemic are depicted in Supplemental Figure 2. From March 2020 onwards (when data on community mobility were available), reduced mobility to various points of sale and other public places was significantly associated with reduced sales for the diversity of tobacco products assessed (Table 2). Every 10% reduction in mobility to retail stores was significantly associated with reduced sales of little cigars (IRR = 0.84, 95% CI, 0.71 to 0.98) and large cigars (IRR = 0.92, 95% CI, 0.88 to 0.96). Large cigar volume sales were further reduced with every 10% reduction in mobility to grocery stores (IRR = 0.87, 95% CI, 0.82 to 0.93) and transit stations (IRR = 0.91, 95% CI, 0.86 to 0.95).

DISCUSSION

We found that the initial shock of the COVID-19 pandemic in June 2020 drove up consumption of cigars, with an initial increased sales of 11.43 million sticks noted for little cigars and 59.02 million sticks for large cigars. Subsequently, volume sales for large cigars declined whereas no change in trend was noted for little cigars. Increases in sales of cigars during COVID-19 have also been reported in other countries,[26] an observation that could be attributed to more aggressive advertising online and in social media since the start of COVID-19. Significant initial increases in little cigars sales were seen starting from April 2020, even though significant gradual increases occurred as far back as January 2020, suggesting a growing and cumulative psychosocial impact from the pandemic. Besides increases in cigars smoked per day among current smokers, the increase in volume sales could also have been driven by increased rates of relapse or initiation. Similar to our findings for cigars, Asare and colleagues (2021), in their investigation of changes in cigarette sales in the US during the pandemic, found a surge in cigarette sales during the COVID-19 pandemic. They estimated an increase of about 0.34 pack per month per capita, corresponding to 14.1% increase above the expected sales, a trend that stands in stark contrast to the rapid declines in cigarette use seen over most of the past two decades.[27,28] If these COVID-related trends persist, they may delay progress in meeting the national target to reduce the percent of adults aged 18 years and over who used a combustible tobacco product every day or some days to ≤5% by the year 2030.[29]

During the study period, reduced mobility to points of sale because of the COVID-19 pandemic was associated with reduced sales of certain tobacco products. These associations

were strongest for little cigars. Little cigars are cheaper than cigarettes but more often sold in smaller pack sizes or single sticks,[17,18] implying that more frequent purchases (conceivably more visits to points of sale) may be needed. Reduced access to such points of sale may therefore explain the reduced likelihood of little cigar sales during periods of reduced mobility. Physical access to points of sale is a major determinant of tobacco use.[30] Furthermore, some of the locked-down places during government mobility restrictions are recreational environments which provide smoking cues, and their lockdown may have contributed to reduced tobacco consumption, including places such as bars, night clubs, and lounges.[31]

Several explanations could be offered for the observation that overall cigar sales during the pandemic *increased* even as less mobility to points of sale during the same period was associated with *decreased* cigar sales. Episodic, brief, or weakly enforced shutdowns could have lowered traffic to tobacco points of sales during the periods the restrictions were in place, while not interfering with sales at other periods. Also, people could have purchased cigars and certain other tobacco products through online or mail-order sales,[32] even if they could not access physical points of sale. Stronger enforcement of access laws such as the federal T21 law, including for online sales of tobacco products,[32] may help reduce tobacco use among youth.

It is now abundantly evident that COVID-19 will not go away overnight, especially as cases continue to increase in many states from the omicron variant. Putting other public health

priorities like tobacco control on hold until COVID-19 is resolved is therefore not an option as both COVID-19 and tobacco use exert a heavy toll on society in terms of premature morbidity, mortality, and economic costs.[27] For example, in the one full year between January to December 2020 alone, COVID-19 claimed 336,802 American lives.[33] Smoking claims lives on a similar magnitude, causing an estimated 500,000 deaths every year.[27] The interaction between these two epidemics (i.e., increased tobacco use during COVID-19), is particularly worrisome as smoking increases the risk for COVID-19 death.[34] Enhanced and sustained efforts to implement evidence-based tobacco control measures are therefore needed, including comprehensive smoke-free laws, increased taxes, hard-hitting warning messages about the harmfulness of tobacco, and offering help with cessation.

This study has some limitations. First, volume sales data may not necessarily translate into actual consumption since not all tobacco products purchased may be used by the consumer. Secondly, different states in the U.S. imposed restrictions at different points and the “shock factor” in relation to COVID-19 may have varied in its timing from state to state. Third, data were not available for novel tobacco products, including hookahs and e-cigarettes. Similarly, as the analyzed data are taxable removals (sales data) rather than population surveillance data, we do not have information on individual-level characteristics such as age, gender, race/ethnicity and disposable income; we could therefore not control for these covariates in our analysis. Fourth, the ‘points of sale’ captured in the Google Mobility data are very broad categories and may be subject to misclassification. More so, the trends capture in Google Mobility data exclude people who turned off their "Location History" setting, those without smart phones, or those with no phones at all. Fifth, we only assessed volume sales as there

were no data on price of tobacco products sold (i.e., value sales) and how this changed during the study period. We therefore cannot make any inferences regarding how much of the change in volume sales was attributable to differences in price during the assessed period. It is also impossible to determine from these data whether changes in volume sales were driven by changes in initiation, relapse, cessation, or tobacco use intensity. For example, with an increase in little cigar sales, we cannot conclude whether this increase is driven by a fixed number of cigar smokers purchasing and smoking more cigars per month, or whether there is an increase in the pool of cigar smokers even if their average cigars per month has remained unchanged, or whether it is a function of increases in both the number of smokers and average cigars smoked.

CONCLUSION

COVID-19 was associated with increased volume sales for cigars, while volume sales for smokeless tobacco plateaued during the study period. There was a significant association between reduced mobility to points of sale and tobacco volume sales, underscoring the role of access in driving tobacco use. These trends are worrisome as they may stall progress made in reducing consumption of certain tobacco products over the past two decades. Even as COVID-19 prevention and control efforts take front and center of the national discourse, tobacco prevention and control efforts must be emphasized+ to reduce tobacco consumption and its associated negative effects on premature morbidity and mortality.

Declaration of interests

The authors declare that they have no competing interests.

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Data sharing statement

All data used in the current study are publicly available secondary data. No additional unpublished data are being withheld by the authors.

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Table 1. Associations between the COVID-19 shock and volume sales of different tobacco products, United States

Tobacco product	Immediate change		Sustained change	
	Regression coefficients, millions of units	P-value	Regression coefficients, millions of units	P-value
Little cigars	11.43 (7.32 to 15.53)	<0.010	0.24 (-2.88 to 3.37)	0.873
Large cigars	59.02 (23.11 to 94.92)	0.003	-32.57 (-54.07 to -11.08)	0.005
Smokeless tobacco	0.55 (-0.55 to 1.66)	0.308	-0.95 (-1.81 to -0.09)	0.031
Pipe tobacco	-0.15 (-0.50 to 0.19)	0.359	-0.07 (-0.22 to 0.08)	0.317
RYO tobacco	0.04 (-0.01 to 0.08)	0.135	-0.01 (-0.03 to 0.01)	0.301

Note: RYO = Roll your own tobacco.

Table 2. Incidence rate ratios with corresponding 95% confidence intervals for the associations between restrictions in mobility (every 10% reduction in mobility) and tobacco sales, March 2020 to June 2021, United States

	Retail and recreation	Grocery and pharmacy	Transit stations
Little cigars	0.84 (0.71 to 0.98)*	0.87 (0.69 to 1.09)	0.85 (0.71 to 1.02)
Large cigars	0.92 (0.88 to 0.96)*	0.87 (0.82 to 0.93)*	0.91 (0.86 to 0.95)*
Smokeless tobacco	0.94 (0.77 to 1.14)	0.89 (0.66 to 1.19)	0.92 (0.74 to 1.15)
Pipe tobacco	0.99 (0.65 to 1.52)	0.99 (0.52 to 1.90)	0.99 (0.61 to 1.61)
RYO tobacco	0.86 (0.14 to 5.26)	0.80 (0.05 to 13.94)	0.85 (0.11 to 6.83)

Note: RYO

Figure 1. Trends in monthly volume sales of little and large cigars during June 2019 to June 2021, United States

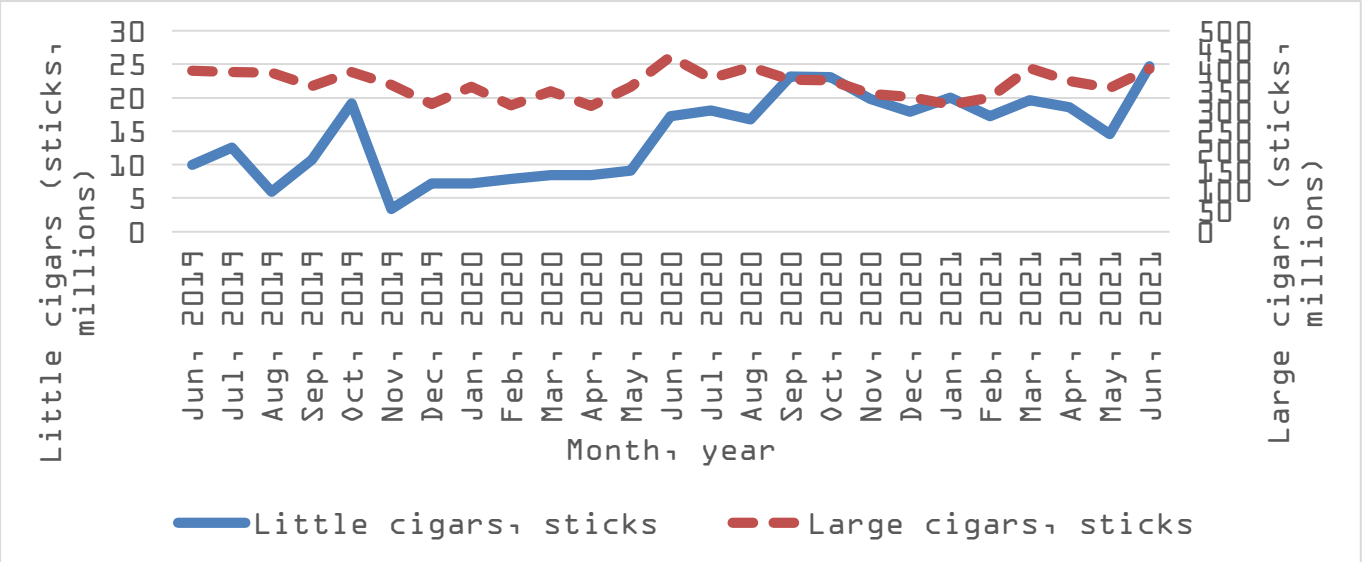

Figure 2 Fitted regression lines before and after cut-off for sales of little cigars from interrupted time series analysis for the period June 2019-June 2021

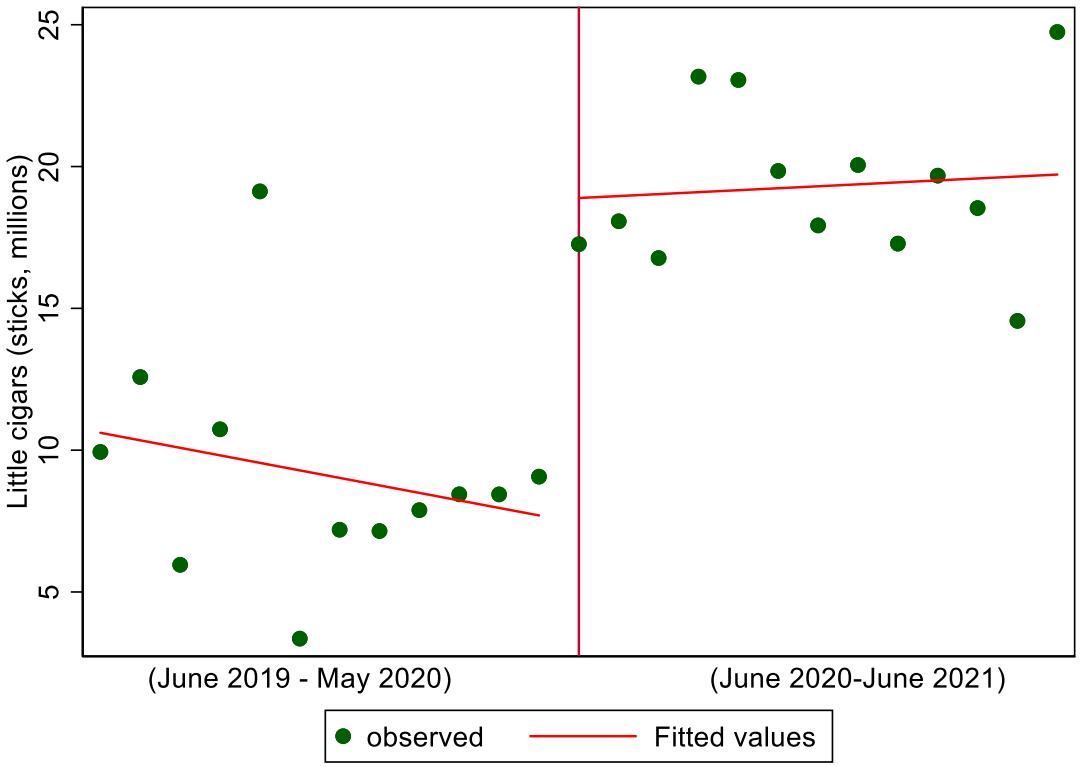

Figure 3 Fitted regression lines before and after cut-off for sales of large cigars from interrupted time series analysis for the period June 2019-June 2021